FLIGHT
The AIRCRAFT ENGINEER & AIRSHIPS

First Aero Weekly in the World

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport

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DIARY OF FORTHCOMING EVENTS.

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:

Nov. 18 ... **Lecture, "The Problem of the Helicopter," by M. Louis Damblanc, before R Ae.S., at the Royal Society of Arts, at 5 p.m.**

Dec. 2 ... **Lectures, "Airship Piloting," by Major G. H. Scott, C.B.E., A.F.C., "Airship Mooring," by Flight-Lieut. F. L. C. Butcher, before R.Ae.S., at Royal Society of Arts**

Dec. 16 ... **Lectures, "Possible Developments of Aircraft Engines," by Mr. H Ricardo, and "The Instalment of Aeroplane Engines," by Mr. A. J. Rowledge, before R.Ae.S, at Royal Society of Arts**

EDITORIAL COMMENT

THE Air Ministry has recently issued a "Notice to Airmen" calling attention to a decree made by the French Government, under which no aircraft is permitted to fly over any town or inhabited district at a less height than will allow of a landing being made outside the town or district or at an aerodrome open to public use, in case of engine failure. The specific heights allowed in the case of multi- and single-engined machines are given in the Notice.

Public Safety in France

The regulations are on all fours with those obtaining here, and may be agreed to be no more than are sufficient for safeguarding the inhabitants and their property. They are not in the least irksome, save possibly to the few "stunt" pilots whose dearest recreation is in flying low over quite unsuitable places and showing off to spectators whose hearts are in their mouths the whole time of the performance. The time and place for that sort of thing is over a properly prepared aerodrome for the entertainment of people who have come to see trick-flying and will be satisfied with nothing else. Aviation is far too serious a matter now for it to be tolerated, and we not only agree in principle with the making of such regulations as we are discussing, but in their most rigorous enforcement. Flying is fighting an uphill battle in the endeavour to get itself recognised as a means of transport. To obtain that the first essential is to get the public to regard it as an everyday, commonplace sort of thing which need not excite remark except upon the wonderful pitch of reliability and certainty at which the aeroplane has arrived. This means the taking of no single avoidable risk, since every public accident, so to say, must have a very adverse effect upon the manner in which aviation is regarded by the man in the street. We have used the word "public" in this connection with intent. What we mean to convey is this: Accidents in aviation are certain to happen, as they occur to railway trains, ships and motor-vehicles. A percentage is quite unavoidable, but we want that percentage to happen as quietly as possible. The appearance of a paragraph in the newspapers, conveying that a machine was compelled to make a forced landing in a field in Kent would excite no remark at all. But the landing of one in the Strand through engine failure would set all London talking about the terrible danger of allowing aeroplanes to fly at all. Provided sufficient height is maintained, there is no need at all for such a thing to occur, but if the regulations are not observed, or if there were no regulations, it would one day happen as certainly as the sun rises and sets. From this point of view the new French decree,

bringing them into line, is absolutely a step in the right direction, and we trust this will be rapidly followed by all nations subscribing to the Air Convention.

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Air Supremacy

Cambridge University is manifesting considerable interest in aviation, and already possesses a very healthy young society of enthusiasts which is, we are confident, destined to do a great deal of good work in developing the movement, both theoretically and practically. Last week Gen. Seely and Lieut.-Col. Moore-Brabazon addressed a packed meeting in the Examination Hall, in speeches urging the University to assist and insist upon the maintenance of the air supremacy we so hardly won in the War.

There is no need to follow the trend of the speeches or to elaborate the argument they strove to point. We ourselves have stressed the point in season and out of season, until our readers are perfectly familiar with every aspect of this vital question. At the moment we feel that it is more important to make a passing reference to the excellent work which is being done at Cambridge, and to urge that the example of the University should be followed generally. In every seat of learning in the country there are to be found numbers of young men of brains and attainment who are inclined to interest themselves in the problems of flight. It is perfectly manifest that much more useful work can be done in association than by the isolated individual, and it seems equally clear that the first step to be taken is the formation and encouragement of similar bodies to that which has come into being at Cambridge. Naturally, we should like to see a faculty of aeronautics at every University in the country. Doubtless that will come in time—possibly before very long—but in the interval something must be done to sustain and foster the inherent interest in aviation which exists in all such communities as we have in mind. Apart from the technical side, which we trust in time to see very fully covered at the Universities, there is also the question of aerial supremacy to be considered. We are all against making the Universities a school for militarist propaganda, but we feel there is no way out of being prepared for anything that may befall. If the Empire is to continue to exist, it must be prepared to resist aggression, particularly from the air. It is to the class which is being educated at our Universities that we looked in the late War for our best pilots, and it is to that class we shall have to look in any future war. Therefore, everything which can assist to maintain interest in the exceedingly wide subject of aeronautics, technical, civil, and military, must be done. Cambridge and Glasgow have given a lead which we trust to see followed with as little delay as possible.

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Setting an Example

There is no example like practical demonstration. Particularly is this so in the case of such a movement as that of aviation, where there is not only prejudice to overcome but actual fear of danger. We have always insisted that it is to what may be called practical propaganda that flight must look to for its future popularity and its hold upon the public. Therefore, the more we can get in the way of facilities for flying the better it must be for the future of the movement, and thus, apart from all other considerations, we think the Royal Aero Club is going quite the right way to work as they have done since August last in acquiring and maintaining for the use of its members a number of different types of aeroplanes. Some six machines have up to the present been acquired, and are kept at the Handley Page aerodrome available for members at a charge of about £5 per hour, which includes all charges, with insurance of the machine and passengers for sums in excess of £25.

It is to be hoped that this tentative scheme will prove a success, as the intention is to acquire a greater number of machines in that event. Not only does this scheme enable the pilot who, after his War experiences, remains keen on flying but has no other opportunities of indulging his favourite recreation to keep his hand in, but it also gives opportunity for a good deal of missionary work. For instance, how often does one hear a discussion on flying in which one side takes the altogether erroneous view that it is a dangerous and an uncomfortable mode of transport? The other party to the argument will have it all the other way, but fails to convince his "opposite number" because there is no chance of demonstrating that the latter is wrong. The Club arrangements fill the gap, where the flying enthusiast is a member. Nothing is easier than to run out to Cricklewood, hire a Club machine for an hour, and show the unbeliever that he is quite wrong.

This sounds a little far-fetched, perhaps, but nevertheless we are honestly of opinion that there is quite a lot of good work to be done in this direction. Whether this is so or not, at least the Club is to be congratulated on giving the idea a chance, in keeping with its functions as a "society of encouragement."

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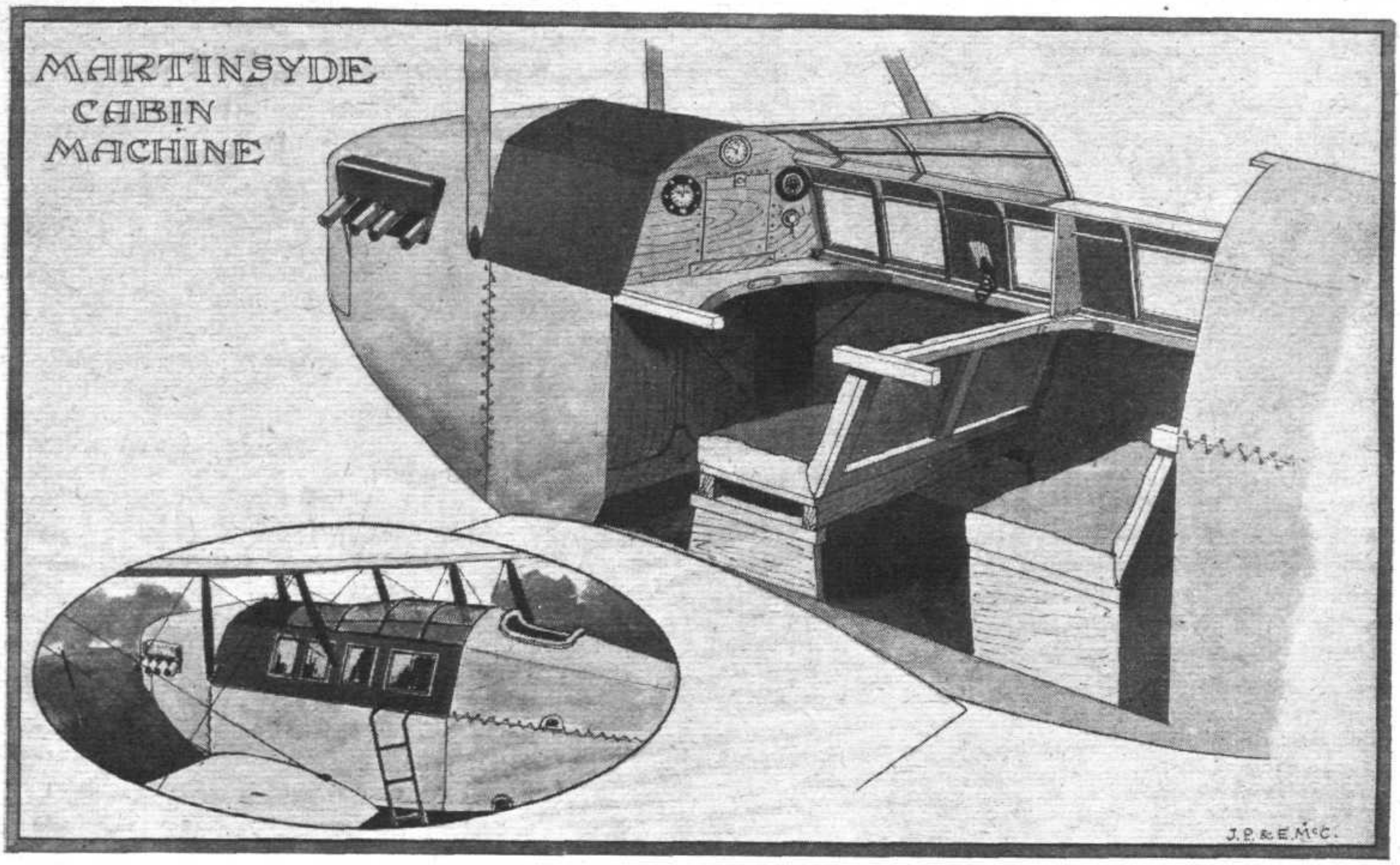
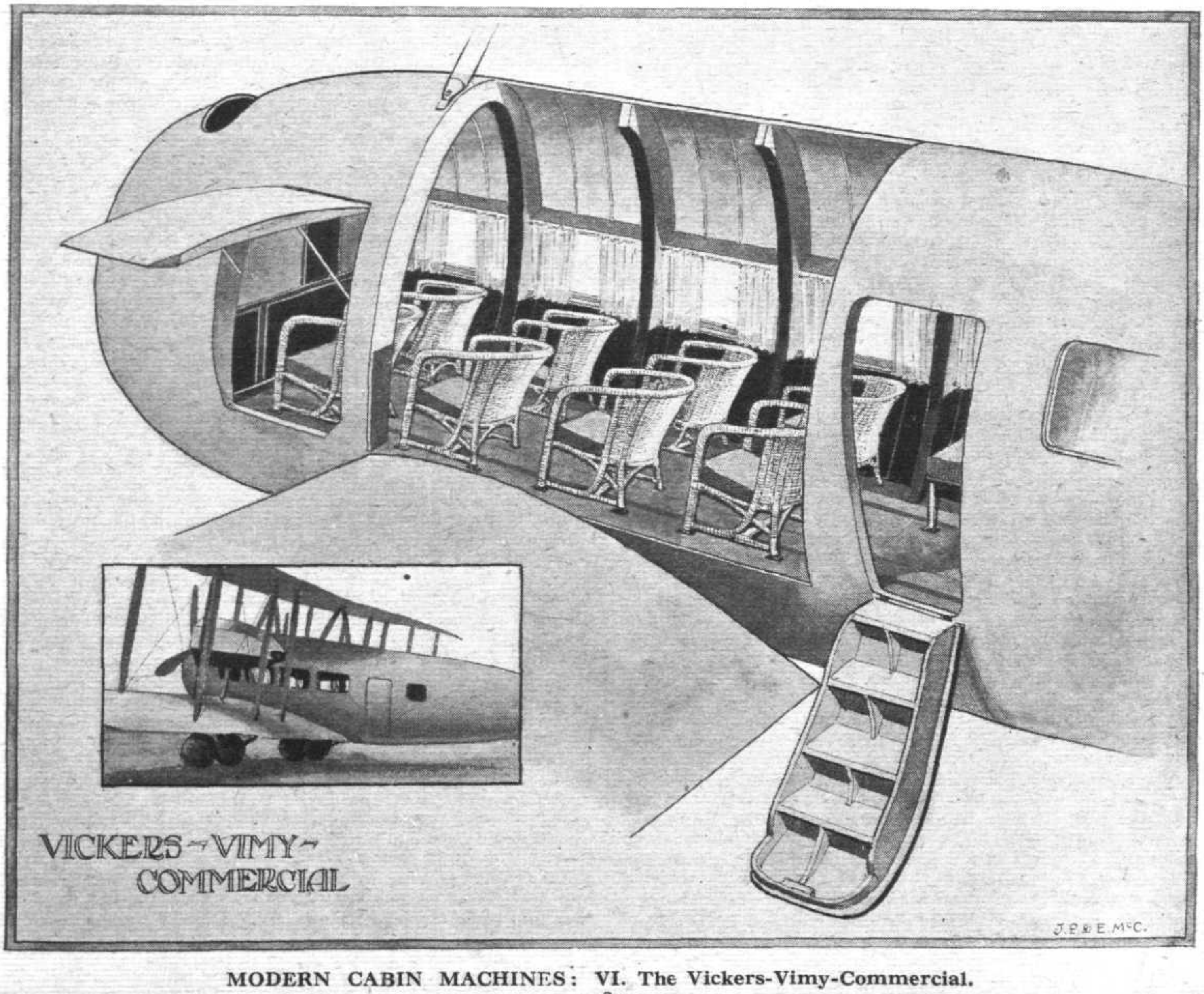
Lighting the Airways

One of the first and principal tasks to be undertaken in connection with the airways of the world is their proper lighting for identification purposes. If commercial flying is really to make good, it is idle to regard it as a mode of transport which can only be carried on in the hours of daylight or in absolutely clear weather. Every competing form of conveyance, whether passenger or goods, can be and is operated as well by night as by day. Fog and thick weather cause delays, but, except on the rarest occasions, do not bring the arrangements to a complete standstill. In the present state of organisation, flying can only be carried on commercially and with certainty in the hours between sunrise and sunset, because of the absence of efficient identification lights and landing marks. We are quite cognisant of the fact that on some of the more frequented airways a good deal has been done in the required direction. The London-Paris route, for example, can even now be used reasonably well at night as in the daylight. In fact, by the time the lighthouses it is projected to build along this route are completed—which will, we hope, be in the very near future—this route will be one which is equally available for traffic right round the clock.

This route is really an example to the world of how things will have to be done to open up and maintain aerial communications all over the world. It is proposed, as mentioned last week, that there shall be no fewer than fifteen identifications lights



MODERN CABIN MACHINES: V. The Martinsyde A.II.



MODERN CABIN MACHINES: VI. The Vickers-Vimy-Commercial.

between Croydon and Le Bourget. Six of these would be in England, and nine between the French coast and the terminal air-port. Each light is to flash its own distinctive Morse signal to inform the passing airman of his position on the route, while the terminal ports will also, as now, be efficiently indicated. One point to which attention has been directed is the necessity for so placing these intermediate lights as to indicate safe landing grounds in case of engine failure at night. It is seldom nowadays that forced landings have to be made on this account, but there must always remain the possibility of such failures, and it is thus very essential that pilots should know that in the vicinity of these landmarks there is open, unobstructed ground available for landing. Obviously, the very worst place for these lights would be in the neighbourhood of inhabited districts, and great care will have to be taken in choosing the most suitable sites. This, of course, applies generally, and not alone to the London-Paris airway. As a matter of fact, we understand that careful thought is being given to the selection of sites for the lighthouses it is proposed to erect on this route, with a particular view to the contingency we are discussing.

In every way the question of lighting the airways is just as important as the lighting of coasts for the assistance of the mariner. In fact, it is even more important, for the reason that ground lights must be the guide to the aerial navigator in the way that the celestial bodies are used for navigation at sea. It is only when the mariner has made his landfall that coastwise lights come into the calculation at all. The airman, on the contrary, must navigate all the time by means of his landmarks, except in the case of trans-oceanic services. Even then, he will be more dependent upon the character and efficiency of lights and landmarks, because of the greater difficulties of navigating precisely by solar and stellar observations. Directional wireless will go far to assist him, but it will nevertheless remain true for a long time to come that the aerial navigator must rely mainly on the assistance that can be given him from the ground.

The R.A.F. and the Unknown Warrior

As was natural, the Royal Air Force took its part in the bearing to its last resting-place, in Westminster Abbey, of the body of "The Unknown Warrior" on November 11. One of the pall-bearers was Air-Marshal Sir Hugh M. Trenchard, Chief of the Air Staff, and in the procession, representative of the fighting forces, was a party of 31 officers and 60 other ranks of the R.A.F.

Also, in the guard, in Westminster Abbey, of those who had won the Victoria Cross, or who distinguished themselves by special valour during the War were the following members of the Royal Air Force:—Wing Commander L. W. B. Rees, V.C., O.B.E., M.C., A.F.C.; Squadron Leader G. S. M. Insall, V.C., M.C.; Flight-Lieut. F. M. F. West, V.C., M.C.; Flight-Lieut. C. J. Q. Brand, D.S.O., M.C., D.F.C.; Flight-Lieut. C. J. Hazell, D.S.O., M.C., D.S.C.; Sergt.-Major J. C. Jones, D.C.M., M.M.; Sergt.-Major G. Scarffe, M.C.; Flight-Sergt. J. Cartwright, D.C.M.; Sergt. S. L. Lee, D.S.M.

Lectures to Aircraft Students

Two full-time courses—one dealing with design and engineering and the other with meteorology and navigation—have been arranged for the 1920-1921 session by the Department of Aeronautics of the Imperial College of Science and Technology, South Kensington. Lectures will be given on the following subjects:—Aerodynamics, mathematics for students of aerodynamics, designs, construction and strength of aircraft, engine design, thermodynamics, meteorology and navigation, and airships.

Air Work in Mesopotamia

In the *communiqué* issued by the War Office on November 3 it was stated:—

"Middle Euphrates.—Hostile concentrations south-east of Hillah were bombed by our aeroplanes on the 31st. Our machines were fired on, but no damage was done."

The following was in the *communiqué* issued on November 5:

"Middle Euphrates.—Several hostile gatherings in the area south-east of Kufa were dispersed by aeroplane attack on Nov. 1 and 2. On the 1st one of our aeroplanes on reconnaissance was forced to land nine miles south-east of Hillah. Another aeroplane, observing that an Arab band was approaching, landed and brought away the pilot and observer. The abandoned machine was burnt by the Arabs."

The *communiqué* issued on November 8 stated:—

"Middle Euphrates.—Our aeroplanes have continued active against hostile gatherings south-east of Kufa. One pilot has been wounded."

The *communiqué* issued on November 10 stated:—

"Lower Euphrates.—A column from Samawa, carrying out punitive operations on both banks of the Euphrates around Khidr, met with stubborn resistance on the 6th from an insurgent band concealed in the nullahs and broken country on the left bank of the river. Our infantry, assisted by aeroplanes, forced the Arabs from their positions.

"Diyala Area.—Nineteen Ford vans, moving from Shahraban, were attacked in the pass of the Jebel Hamrin range on the 4th . . . . Aerial reconnaissance over the area on the 5th reported no sign of any hostile concentration."

The *communiqué* of November 17 stated:—

"Lower Euphrates.—A column from Samawa, assisted by aeroplanes, has carried out punitive measures north of Khidr (south-east of Samawa)."

Japan's Share of German Aircraft

Japan is to receive about 50 machines of recent design, seized in Germany by the Inter-Allied Commission. A considerable sum has been voted by the Japanese Government for the construction of hangars at the military aerodromes of Tokorozawa and Kagamigahora; and two airship sheds at Juterbog, near Berlin, are to be taken down, sent to Japan and re-erected with the aid of German engineers. Japan is also expecting to receive one of the Zeppelins at Seddin, Pomerania.

To Reconnoitre Mount Everest

Reading a paper before the Royal Geographical Society on November 8 on the proposed attempt to climb Mount Everest, Brig.-Gen. the Hon. Charles Bruce said it was hoped that the Government of India would place aeroplanes, for reconnaissance purposes, at the disposal of the next party to make the attempt. Reconnaissance, camping grounds, and the establishment of depôts could not be the only difficulties. Teams would have to be trained and men tested. The Alpine Club members were to organise and carry out the actual climbing of the mountain, and the Geographical Society would undertake the scientific side of the work, in which they hoped for the co-operation of the Survey of India.

Air Supremacy at Cambridge

At a meeting organised by the Air League in conjunction with the Cambridge University Aeronautical Society on November 10, Major-General J. E. B. Seely, M.P., gave a lecture on "Air Supremacy." After pointing out the importance of aviation to a scattered Empire like the British one, he said that for generations we must carry our foodstuffs on the sea, and must therefore maintain our care of the surface of the sea. Our Navy, without aircraft, would be helpless against an enemy that had powerful aircraft co-operating with its Navy.

He went on to emphasise the need for research work with the object of producing all-metal aeroplanes and machines capable of landing in restricted spaces. In work such as this he felt certain Cambridge University would play a great part. He also felt sure that the Government would take all possible steps to ensure the success of civil aviation.

Lieut.-Colonel Moore-Brabazon, M.P., said he believed the Government were sympathetic towards aviation, but owing to the period of economy they were in, the Government dared not spend a penny for aviation till they were pushed into it. Some years ago they had a Blue Water School; they had come to plead for a Blue Sky School, and he hoped that night was the beginning of that school.

THE F.I.A.T. TWELVE-SEATER BIPLANE

UP to now large machines carrying passengers to the number of ten or more have generally been of one type, in which multiple-engines are mounted on the wings, either in separate *nacelles*, or in auxiliary *fuselages* as in the Caproni. The single tractor-screw *fuselage* type of machine is practically unknown in the "larger sizes." No doubt the principal reason against the use of this type for large machines is the question of obtaining single engines of sufficiently high power, or the difficulty of gearing satisfactorily more than one engine to a single screw.

The well-known House of Fiat, however, have recently designed a large tractor biplane, which, apart from the question of type, possesses several interesting features, and we give herewith a description, together with scale drawings, of this machine.

The principal feature of this machine consists of the arrangement of the power plant. This is the patent Fiat triple-engine unit, which is mounted in the nose of the *fuselage* as in an ordinary single-engine tractor machine. It consists of three vertical engines grouped side by side, each driving a single tractor screw through a gear-box. Should any one of the three engines develop trouble, it is automatically cut out from engagement. Means is also provided whereby any of the engines may be disengaged by the pilot or mechanic, as required, thus enabling certain repairs or adjustments being made whilst in the air. As the maximum combined horse-power developed by the three engines (900 h.p.) is well above that required for normal flight, the cutting-out of one engine—whether by accident or design—results only in a decreased r.p.m. of the tractor screw, with a corresponding decrease in the speed of the aeroplane, which is, however, quite sufficient for safe flying. It is claimed for this arrangement that it possesses the advantages of the single-engined tractor type, combined with those of the multiple-engined systems. The maximum horse-power of 900 (1,850 r.p.m.) is only occasionally used, the normal power developed being 700 h.p. (1,600 r.p.m.), when the speed of the machine is in the neighbourhood of 115 m.p.h.—the maximum speed is 125 m.p.h., whilst it is claimed that the landing speed is as low as 50 m.p.h.

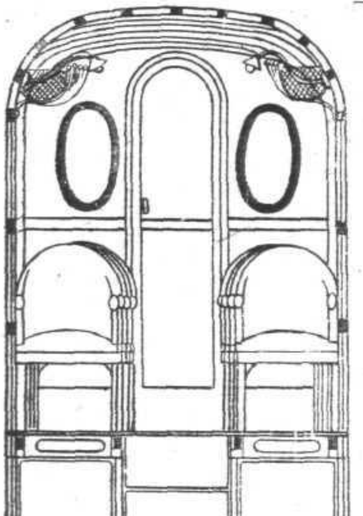
The arrangement of the *fuselage* also has several points of interest. The *fuselage* is exceptionally deep overall, being only a little less in depth than the gap of the planes, the measurements being 8 ft. 3 ins., and 8 ft. 6 ins. respectively. The main structure of the *fuselage*, carrying the principal weights—power-plant, tanks, cabin, etc.—forms the lower half, the upper half being, to all intents and purposes, a cowling or turtle deck. The main structure is a combination of girder and 3-ply construction, rectangular in cross-section and tapering to a vertical knife-edge at the rear. The middle portion of the *fuselage* constitutes the passengers' cabin and lavatory. The main cabin is 10 ft. 6 ins. in length, and has an average height and width of 6 ft. and 5 ft. respectively. There are two rows of five comfortably-upholstered seats, with a central gangway between them, from which two flights of steps—one coming from the pilot's cockpit in front—lead to a trap-door in the bottom of the *fuselage*, the floor of the cabin being about two feet above the latter.

In the sides of the cabin above the top longitudinal of the main *fuselage* structure are sliding windows, extending from end to end, and providing a fairly good view below. At the rear of the cabin is a small compartment fitted as a lavatory. The pilot's and mechanic's cockpit is located immediately in front of the cabin, high up in the *fuselage*, beneath the front main spar of the top plane. In this position the pilot has an excellent view forward and downward, although somewhat restricted in an upward direction. If necessary, the mechanic can take control of the machine by means of a dual-control system. The pilot's cockpit is separated from the engine compartment immediately in front by a partition in which is a sliding door giving access to the engines. A certain amount of warm air, from the radiator, is allowed to enter the pilot's cockpit.

The fuel tanks, which have a total capacity sufficient for a flight of 6 hours or 600–750 miles, are located below the floor of the cockpit and stairway leading from the latter to the cabin.

The main planes have neither sweep-back nor stagger, but the lower plane, which is of shorter span than the upper one, is set at a dihedral angle of about 2 degs. Except for the incidence wires there is no external wire bracing, owing to the employment of the Warren type of interplane-strut bracing.

Ailerons are fitted to the top plane only, and these are balanced by means of a small horizontal surface mounted in

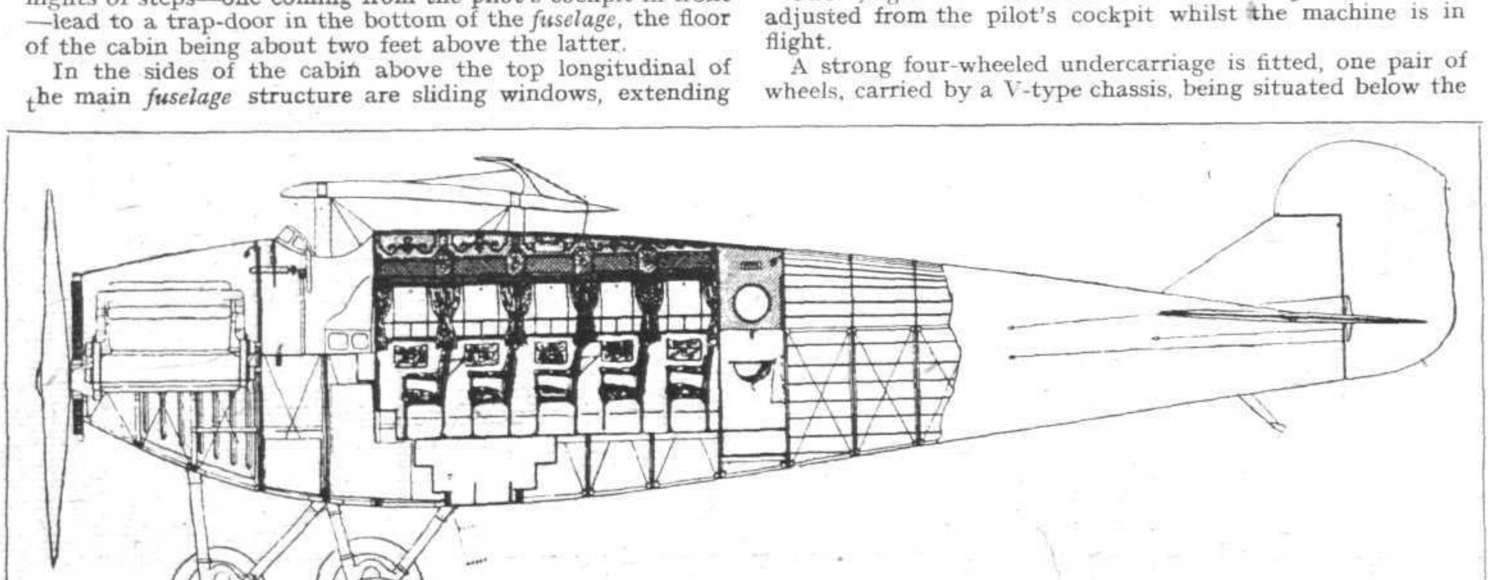


The F.I.A.T. Twelve-Seater Biplane: A cross-section through the *fuselage* (cabin portion)

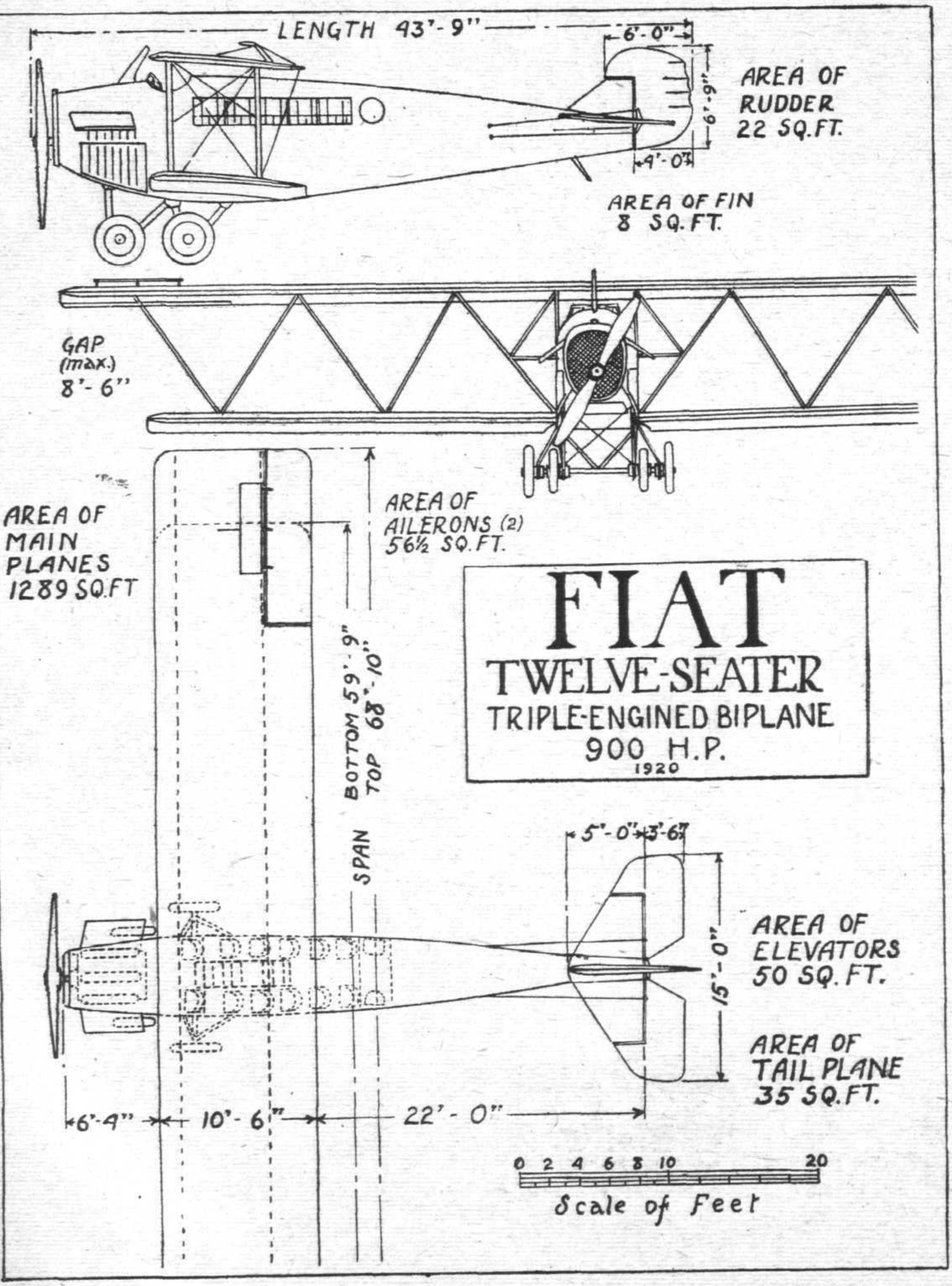
front of and above the *aileron*. The rudder and elevators are balanced in the usual way, by means of forward projecting surfaces.

The angle of incidence of the tail plane can be adjusted from the pilot's cockpit whilst the machine is in flight.

A strong four-wheeled undercarriage is fitted, one pair of wheels, carried by a V-type chassis, being situated below the



THE F.I.A.T. TWELVE-SEATER BIPLANE: Sectional side elevation of the *fuselage*, showing cabin arrangement, etc.



THE F.I.A.T. TWELVE-SEATER BIPLANE: Plan, side and front elevations to scale

planes, and the other pair, also carried by a V-chassis, being mounted forward. A factor of safety of over eight is employed throughout the construction of this machine.

The principal characteristics of the Fiat 12-seater are :—

Span (top plane)	68 ft. 10 ins.
Span (lower plane)	59 ft. 9 ins.
Chord	10 ft. 6 ins.
Gap (maximum)	8 ft. 6 ins.
Overall length	43 ft. 9 ins.
Overall height	14 ft. 9 ins.
Area of main planes	1,289 sq. ft.
Area of *ailerons* (2)	56½ sq. ft.
Area of tail plane	35 sq. ft.
Area of elevators	50 sq. ft.
Area of fin	8 sq. ft.
Area of rudder	22 sq. ft.
Weight empty	7,040 lbs.
Weight laden	11,000 lbs.
Weight (sq. ft.)	8.6 lbs.
Weight (h.p.)	12.2 lbs.
Speed range	50–125 m.p.h.
Ceiling (full load)	15,000 ft.

NOTICES TO AIRMEN

(No. 121) France : Regulations regarding Flight over Inhabited Areas: Flying of Captive Balloons

1. By a Decree of the French Government dated August 26, 1920, published in the *Journal Officiel* of August 29, 1920, relative to the regulation of Air Navigation, Lights and Signals, the following regulation was brought into force :—

(Article 48, Chapter VI). "No aircraft shall fly above a town or any inhabited district except at such an altitide that, in the event of the failure of its means of propulsion, it can land outside the town or inhabited district, or upon an aerodrome open to public use."

In order that this regulation may be clearly interpreted, the following amplifying rules have now been applied by the French Government :—

(i) No inhabited district, no matter what its size, may be flown over at an altitude of less than 500 metres (1,640 feet)

(ii) Towns of 10,000 to 100,000 inhabitants may not be flown over at an altitude of less than 500 metres (1,640 feet) in the case of multi-engined machines, and less than 1,000 metres (3,281 feet) in the case of single-engined machines.

(iii) Towns of more than 100,000 inhabitants may not be flown over at an altitude of less than 1,000 metres (3,281 feet) in the case of multi-engined machines, and less than 2,000 metres (6,562 feet) in the case of single-engined machines.

2. *Flying of Captive Balloons.*—The French Government (Minister for War) has given notice that Captive Balloons may be flown in normal weather in the following districts :—

(*a*) *Captive Balloons for Observation.*—St. Cyr, Compiègne Epinal, Angers, Cosne, Nevers, Privas, Toulouse.

(*b*) *Anti-Aircraft Captive Balloons.*—Sedan, Toul, Lure, Sathonay, Montargis.

These balloons may be flown in foggy as well as in clear weather. The mooring cables will be marked in the regulation manner, in accordance with the International Air Convention.

3. *Authority (for Para.* 2).—French Notice to Airmen No. 19 of October 30, 1920.

(No. 122) France : St. Inglevert Aerial Lighthouse

1. The aerial lighthouse at St. Inglevert Aerodrome is out of action until further notice. Para. 1 of Notice to Airmen No. 98 of September 24, 1920, is amended accordingly.

2. *Authority.*—French Notice to Airmen No. 18 of October 27, 1920.

(No. 123) Meteorological Reports. W/T Routine

Under this number the Air Ministry has issued a long notice giving details of the method followed since midnight, November 5-6 in sending out meteorological reports by wireless on civil air routes. Owing to its length it is not possible to give this notice in full in our columns, but all pilots who have wireless apparatus fitted to their machines and all aircraft wireless operators should make a point of obtaining from the Air Ministry a copy of the notice. It cancels notices Nos. 88 and 110 of 1920, and amends paragraph 1 of Notice No. 94 and the footnote to paragraph 6 of Notice No. 98.

The notice gives details of the times and make-up of the hourly meteorological messages sent from English and French stations, and particulars of the wave-lengths used for various kinds of messages.

ROYAL AERONAUTICAL SOCIETY NOTICES

Lectures.—The paper on "The Problems of the Helicopter," by M. Louis Damblanc, will commence at 5 p.m. on Thursday, November 18, at the Royal Society of Arts, John Street, Adelphi, when Air Vice-Marshal Sir E. L. Ellington, K.C.B., C.M.G., C.B.E., will be in the Chair.

Air Marshal Sir Hugh Trenchard, K.C.B., D.S.O., will take the Chair at the following meeting at 5.30 p.m. on Thursday, December 2. Two papers will be read : "Airship Piloting," by Major G. H. Scott, C.B.E., A.F.C., and "Airship Mooring," by Flight-Lieutenant F. L. C. Butcher, R.A.F.

Annual Dinner.—The annual dinner will take place at the Connaught Rooms on Wednesday evening, November 17, at 7 for 7.30 o clock. The President, Right Honourable Lord Weir of Eastwood, will be in the Chair. There will be four speeches only, and a good vocal and instrumental concert has been arranged to follow the dinner. The artistes will be Miss Diana Laurence (Soprano), Miss Laurie O'Beirne (Violinist), and Mr. Whittenbury Kay (Baritone). At the piano, Mrs. Fem Cooper.

Scottish Branch.—Air Commodore Brooke-Popham, C.B., C.M.G., D.S.O., A.F.C., will lecture on "Lines of Future Progress in Aeronautical Research," on Thursday, November 18, at the Engineers' Institute, Glasgow. Brigadier-General J. G. Weir, C.M.G., F.R.Ae.S., will take the Chair.

Mr. J. L. Bartlett will read a paper on "Airships : General Principles," on Monday, November 22, and on "Rigid Airships : Design and Materials," on Tuesday, November 23. Both lectures will take place at 7.45 in the Engineering Class Room at Glasgow University.

Examinations Committee.—A meeting of this Committee was held on November 11, when Dr. L. Bairstow (Chairman), Wing-Commander Cave-Browne-Cave, and Dr. R. Mullineux-Walmsley were present. Draft regulations for the examinations prepared by the Chairman were discussed and approved with certain slight modifications, and will be brought before Council at their next meeting.

Library.—The following books have been received and placed in the library : "Dynamics of the Aeroplane," by René Devilliers, and "The Complete Airman," by G. C. Bailey, D.S.O.

W. LOCKWOOD MARSH, Secretary.

Opportunities in China

French manufacturers are being urged to consider the possibilities of China. One Frenchman, M. Ricou has established one service from Makao to Shanghai, but he uses Curtiss machines. A suggestion has been made that waterplane services should be organised over the Hoang-Ho and Yang-tse rivers, and their estuaries. A Conference is being held at the French Air Department on November 17 when M. Painleve will report on his recent observations in China.

A Triangular Race in New York

Instead of the race across the American Continent, which was originally planned to take place this month, it has been decided that the contest for the Pulitzer Trophy on Thanksgiving Day, November 25, shall consist of a 160-mile race round a triangular course, starting from and finishing at Mineola, N.Y. Eighteen U.S. Army and eight Navy machines have been entered, and it is hoped that at least forty machines will compete.

CAMBRIDGE UNIVERSITY AERONAUTICAL SOCIETY

(OFFICIAL ORGAN, "FLIGHT")

A Paper on "Spins"

THE ninth meeting of the Society took place in the Engineering Laboratory on November 3, at 8.30 p.m., the President being in the Chair.

The President said that the lecturer of last week paid a graceful and a generous tribute to the work done by Cambridge men in aeronautics, and that the lecture that night would be given by one to whom that tribute was so deservedly paid. Mr. H. Glauert obtained a First Class in the Mathematical Tripos in 1913, and went to Farnborough in 1916, and since that time he had been doing some valuable work, of which he was going to tell the meeting something that night. He was sure that the Society would be pleased to hear of Mr. Glauert's election to a Fellowship at Trinity. He then called upon Mr. Glauert to give his lecture.

Mr. H. Glauert, M.A., A.F.R.Ae.S., then delivered the following lecture :—

"Spins"

Viewed from the ground, a spin can be described by saying that the aeroplane descends almost vertically and rotating rapidly, and from the point of view of the pilot, the rotation is also observed by the peculiar behaviour of the ground, and the force by which he is pressed into his seat. The one peculiar thing from the point of view of the pilot, however, is that although the aeroplane is pointing nose down to the ground, there is no tendency for him to fall forwards in his seat, as there is in an ordinary dive.

In the early days of flying, the spin was known simply by virtue of the number of accidents which it caused. It was known that at times an aeroplane became uncontrollable and fell into a spin, and the result was usually a bad, and often a fatal crash. I can quite well remember my own first experience of a spin. There was a small pusher aeroplane coming down to land at Farnborough. At a height of a thousand feet, the pilot made a bad turn, and the aeroplane fell into a spin, from which it made a partial recovery, and then fell into another spin. In those days, a spin was regarded as a form of instability. If an aeroplane got into a spin, the pilot might make an attempt to get out of it, but it was more by good fortune than by good judgment that he succeeded in doing so. One of my objects to-night is to show you that the spin is not a form of instability, but one of the possible steady motions of an aeroplane.

Now I must first digress a little to talk about the stability of an aeroplane. Suppose we think only of motion in the plane of symmetry, ignoring banking and turning. There is only one possible steady motion for an aeroplane under these conditions. It must fly in a straight line. Of course, it may be climbing or diving down, it may even be coming down vertically or flying on its back. There is also a series of periodic motions, with the oscillation neither increasing or decreasing. You might imagine, for example, a series of stalls and dives, or a succession of loops. The conditions at each moment vary in a periodic manner. Well now, whatever your aeroplane is, it must settle down eventually to one of two things. It must either settle down to a steady flight in a straight line, or to one of the periodic motions. But in talking of the problem of stability, we think of the straight line flight as a steady condition, and see what happens if there is a small divergence from these steady conditions. If the disturbances die away, the aeroplane is said to be stable, if they increase with the time, it is unstable. That is the problem of stability worked out by Professor Bryan and other writers. But the stability analysis does not say anything of what the subsequent state of the aeroplane will be. It only considers the conditions in the first few seconds. The aeroplane must eventually settle down to steady flight under some other conditions, either the straight line, or the steady oscillating movement. An unstable aeroplane, for example, is known to be generally stable on its back. We have had numerous cases of that, where the aeroplane is unstable in flying in the ordinary manner. If released, the aeroplane will settle down and glide to the ground upside down.

In the general case there is another possible steady motion, the helix or steady turn. You will probably know this motion as the spiral glide, and I may seem pedantic to refer to the path as a helix. It is necessary to do this, however, in order to distinguish the steady motion from the form of instability called spiral instability. In this general case there is another series of steady periodic motions which are really undamped oscillations about the helix. Very little work has been done on the stability of this helical motion. Our knowledge is confined mainly to the case of the straight line as the steady motion.

In this problem, instability arises in two ways ; one, which is called spiral instability, occurs if the fin and rudder of the aeroplane are too large, when the aeroplane turns more and more rapidly, banking up all the time, and eventually will settle down to some other condition. But the stability analysis says nothing of that. The other form of instability has always been known as spinning instability, and occurs when the fin and rudder are too small. The aeroplane then whips round suddenly instead of this slow gradual turn, and as it turns, its outer wing goes faster, the nose drops and again you have got something similar to what happnes after the spiral instability. Well, the aeroplane eventually must settle down to something. It must fly in a helix, if not in a straight line, and that is why the spin was so often the result of instability. It is not the instability itself, but the steady motion to which the aeroplane settles down. I have mentioned the accident I saw to a pusher scout. At that time, there was no general knowledge of how to deal with an aeroplane when it got into a spin. Some pilots had recovered from spins, but it was not known certainly what was the proper course of procedure if the aeroplane got into that condition. The only thing to do was to avoid getting into a spin. These accidents were unfortunately rather frequent on the F.E.8, but the chief experimental pilot at Farnborough, Major Goodden, was convinced that it was possible to get an aeroplane out of a spin, and to test his convictions he went up in one of the aeroplanes, put it into a spin, and brought it out successfully. I will read you the report of that experiment in his own words.

"At a height of 3,500 ft., I put on gradually full right rudder, and at the same time gradually pulled the control-stick over to the left. In this way, the aeroplane was turned to the right without any bank. When I had turned the machine in this manner for about 180°, the speed had dropped, due to the turn and the resistance of the fully-over rudder and flaps, to nearly the stalling speed. The nose of the aeroplane then went gradually down, due to the loss of speed. I next pulled back the control-stick, and this increased the turning speed, and when I had completed 300° turn the spinning suddenly started.

"I kept the control-stick in the position described above, and the spinning continued, and gradually got steeper. The whole aeroplane was then turning about a point mid-way between the right hand wing-tip and the body.

"In this way I tried three spinning tests to the left and three to the right, and whereas spinning starts after about 300° on the right-hand turn with control as described above, spinning to the left does not take place until a turn and a half had been completed.

"In bumpy and disturbed air a turn attempted with the controls set in the manner described would undoubtedly start the aeroplane spinning much earlier than the turn.

"The following was the procedure adopted to get the aeroplane out of the spin :—

"(1) Switch off motor.

"(2) Control-stick put central and pushed forward.

"(3) Rudder put in centre.

"This resulted in a nose dive, from which the aeroplane, having once got up speed, can easily be pulled out with the control-stick pulled back slightly.

"If the aeroplane is dived to bring it vertically downwards, spinning cannot continue, provided all the controls are central.

"This aeroplane is perfectly stable and is as safe from spinning as any aeroplane I have flown. There are large elevator, rudder and wing-flap surfaces, and the controllability of the aeroplane is consequently very great. This controllability, which is so desirable in any aeroplane, and particularly in a fighting machine of this type, should it be misused, must result in upsetting the whole stability of the aeroplane. Similarly, if the aeroplane is allowed to get out of control, then, if care is taken to make the correct movements required by the particular conditions, these powerful control will enable the aeroplane to be readily brought under control again.

"I could only succeed in making the aeroplane spin by the misuse of the controls I have described, and from reports I have of the spinning accidents to F.E.8 aeroplanes, this seems to have been the cause."

Well, there are two points in that report to which I want

to draw your attention. The first is Major Goodden's method of starting a spin. He started it by putting on the rudder and pulling the control-stick over to the opposite side. We know now that the most effective way of starting a spin is to pull back the control-stick first and to stall the aeroplane. The second point is the way he emphasises the fact that the spin is the result of bad flying, and is to be avoided. In those days the spin had not become a general manœuvre of all pilots.

A little later there was a further series of accidents on another aeroplane, due mainly to engine failure when getting off the ground. When the engine failed it started turning, due to the turning tendency and increased by errors of judgment of the pilot, and the aeroplane developed a spin. By that time, pilots knew how to get out of a spin. There was no danger, but for the fact that the aeroplane was too close to the ground, and thus at an insufficient height to enable it to recover from the spin. I think it was this series of accidents that really started the proper investigation of the spin. All the earliest experiments were carried out by Dr. Lindemann on a B.E.2E aeroplane, and since that date the examination of the characteristics of an aeroplane in a spin has become almost a routine job in testing any new type.

The characteristics that are common to the spin of nearly all aeroplanes are first, that the speed is only about 60 m.p.h. The second easy point which can be settled about the spin is the rate at which the aeroplane is turning round. This, of course, varies for different types, but for a small scout or fighting aeroplane, such as the Camel or S.E.5, the period is about 2 secs. For a two-seater B.E.2E it is about double—3½ to 4 secs.; and between those two limits we have the Avro with 3 secs., and the Bristol Fighter and F.E.2B with 2½ secs. The last is the most surprising, for we should expect a small fast aeroplane to turn quicker than a slow and larger one, and yet the F.E.2B rotates nearly as fast as the S.E.5. There is apparently no direct connection between the size of the aeroplane and the rate of the spin, or it is obscured by other factors. Still, a good many of these possible factors have been investigated. Take first of all the shape of the wings. We have tried a Bristol Fighter with wings of three different aspect ratios. With the ordinary aspect ratio of 7½, the rate of spin was 2½ secs. When the aspect ratio was increased to 9½, the period went up from 2½ to 3½ secs. When it was cut down to 4½, the period dropped to 2¼ secs. This change in rate of spin with aspect ratio agrees with the type of thing we should expect. I shall return to that later.

Now, as to the controls and the best position in which they should be for a spin. First of all, I will take the *ailerons*, because there is probably more controversy about them than others. It is impossible to get a definite conclusion as to how the *ailerons* should be held in a spin. Some pilots prefer to have them crossed, that is, right rudder, left *aileron*; others prefer them the same way, but one thing is certain, that the spin cannot be started in some aeroplanes unless the controls are crossed. Crossing the controls certainly helps to start an aeroplane spinning; whether the aeroplane spins better with them crossed or with them both in the same direction is uncertain. I believe the French did not allow crossed controls in a spin on the plea that it caused greater stresses and a jerky spin. We can see a little in a general way how the *ailerons* affect the problem. Suppose you are spinning to the right with the left *ailerons* pulled down, you will get a rolling moment tending to turn the aeroplane round in the proper direction, but you get a bigger drag force on the outer wing, and so another moment trying to pull the aeroplane round the other way. In different cases, these two effects may balance out in different ways. On the whole, I think it is safe to say that the *ailerons* are relatively unimportant in a spin though they may be important in starting spins. Let us next consider the effect of the fin and rudder. The rudder is used to start the aeroplane turning, and there is no doubt that as the power of the rudder is increased the rate of the spin is increased. For example, we took a Camel aeroplane, the rates of spin being 2 secs., and fitted it with a larger rudder. The spin then took 1·8 secs. Another example was a Vickers aeroplane, which was rather peculiar. It would not spin at all. Several attempts were made by different pilots, but whenever a spin was started, they found they could not hold it, and always ended in a rather violent spiral. Well, we thought it might be the fin, so we started stripping the fabric from it. We stripped the whole of the fabric, and then the aeroplane was at last made to spin, but it was a very unsatisfactory spin, and the method of coming out was rather too startling for the experiment to be repeated. It proves that the fin had been the cause of the initial difficulty of spinning this aeroplane. The remaining control is the elevator, and this is undoubtedly the most important in the spin. The elevators must be held right up, and there is no way of getting a spin with the stick forward. To start the spin, Major Goodden did a flat turn, and then eventually pulled back the stick. The flat turn started a banking movement and speed was lost. Now the standard way of starting a spin is to pull back the stick, thus losing flying speed, and kick over the rudder. You start the turn in the direction required, and occasionally it is necessary to cross the *ailerons* as well, but if you had a larger rudder, it would not matter what you did with the *ailerons*. It is the usual way of starting a spin, but it is by no means the only one. It is quite possible to turn an ordinary spiral or helical glide into a spin, by pulling back the stick, and by putting on full rudder. This is shown very clearly in some of the experiments with a B.E.2E aeroplane by Dr. Lindemann. He started a spin with a period of about 4 secs. He turned from this spin into a spiral, and then turned back to a spin, rotating all the time. He was never in a straight dive at any time. But it is a very delicate manœuvre, and not to be recommended. It causes far higher stresses on the aeroplane than the ordinary method.

To start a spin, you pull the stick back, and put the rudder over; to stop it you do the reverse. You push the stick forward, and put the rudder in the centre, and that is obviously one of the difficulties pilots must have experienced in the early days. As the aeroplane was pointing steeply downwards, the natural tendency must have been to pull the stick back. What they ought to have done was to push the stick forward in order to stop the rotation. It is easy to understand now, but until it had been successfully accomplished, the spin was always a fatal accident. With a stable aeroplane, it is often sufficient merely to abandon the controls and the aeroplane will come out. It is true, for example, that in the S.E.5 it is not necessary for the pilot to make a definite motion of pushing the stick forward. He lets go and the aeroplane comes out. Of course it will take much longer than if he directs it in the proper manner, but it will come out. With an unstable aeroplane this is not the case, and there the correct motions must be made to stop the spin. In general, simply pushing the stick forward and putting the rudder central is the simplest and best way, but other methods have been attempted with success. First of all, if you put the rudder opposite instead of merely central, you will obviously apply greater force, and if that is done until the rotation ceases, you will gain a little in the recovery. Again, if you have the stick right forward, you will come out in a very steep dive. At times it is sufficient to push the stick central instead of right forward. But the question has to be studied for each particular aeroplane. In some cases, for instance, on the Camel, if you put the rudder opposite, it does not even stop the spin; it goes on spinning against the rudder. There the stick must be forward. In the S.E.5, on the other hand, the rudder will stop the spin, even if the stick is back. The rudder must be used to stop rotation, and the aeroplane will come out as soon as the rotation is stopped. The most important thing is the height required to get out of the spin, and as an average figure 500 ft. seems to meet the case. Occasionally you get a recovery at as low a figure as 350 ft., and at times it rises much higher. In fact, there were tests not so long ago on a certain single seater, which took over 2,000 ft. to come out. There is another difficulty about the unstable aeroplane in the spin—that is, when you come out from the dive, to avoid stalling the aeroplane again and so starting a second spin, the more so because after the rotation which the pilot has been undergoing, it is often very difficult for him to judge what is level. If you watch an aeroplane come out of a spin, you can generally see that the aeroplane is flying with one wing down, and if stalled in that condition, probably it would mean a second spin. That is a point of advantage on the side of the stable aeroplane.

I now pass to the more detailed analysis of the motion. Fig. 1 shows records of the speed and acceleration in a spin, that is, the force at right angles to the wings. The top record is from an S.E.5A. First comes the stall where the speed drops to about 40 m.p.h., next the steady spin at about 60 m.p.h., and finally the dive and recovery. The other two records are from a Bristol Fighter. The bottom one gives only the acceleration, and shows a remarkable oscillation about the steady motion with a period of about 1·5 secs. This shows quite clearly that the aeroplane is doing a small oscillation about its steady motion of spinning. The middle record gives both the speed and the acceleration, and the oscillation is again shown quite clearly.

Besides measuring the speed, acceleration and rate of rotation, we also obtained the rate of descent or vertical velocity, the radius of turn, and readings of lateral and longitudinal bubbles to give the direction of the resultant force. These results were more than sufficient to determine

the motion completely, and Fig. 2 shows some of the deductions made. At the top we have the variation of speed across the wings—the two wings are moving at different speeds, and there is also a variation across the span. The other diagram shows the variation of incidence, the angle at which the air strikes the wing. This is large, almost 1° per foot of the span, and another point to note is the average value, which is

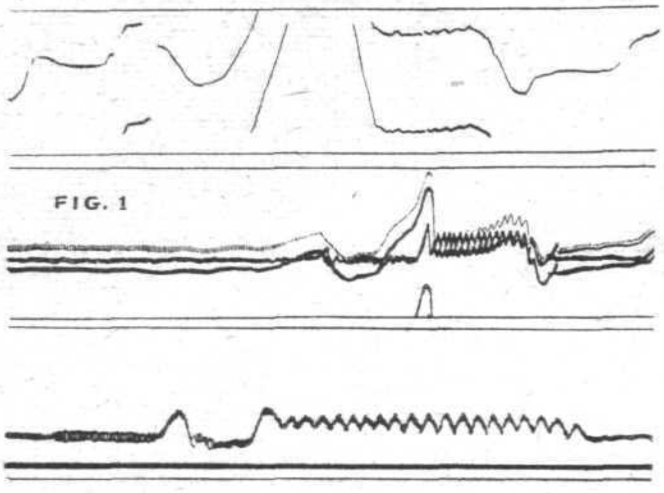


FIG. 1

higher than the stalling angle. This was the most startling result we obtained, and is the essential difference between a spin and an ordinary spiral or helical glide. To verify this result, long poles were fixed to the wing struts, which carried streamers several feet in front of the wings. The position of these streamers was observed on graduated cross-pieces during a spin. The observed angles were 15° and 35°, and these agreed quite well with the calculated values 17° and 37°. As a result of the peculiar distribution of incidence the stresses on the wing structure are very different from those occurring in ordinary flight, but calculation showed that the ordinary wing structure was quite strong enough for spinning.

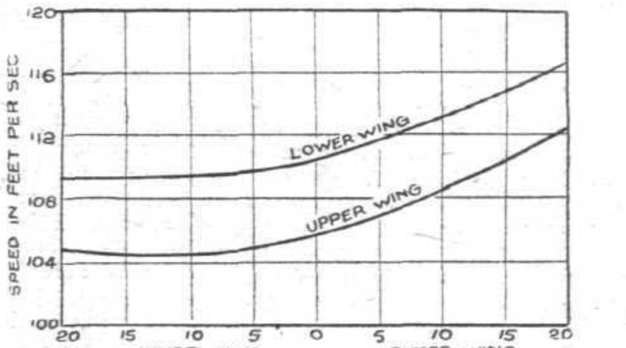


FIG. 2

Fig. 3 shows the lift and drag coefficients obtained in the different experiments, but of course it must be realised that they represent mean values for the peculiar distribution of load which occurs. First of all, notice the high angles of incidence. The lift coefficients fit quite well on to the curve obtained in ordinary conditions, and show the kind of curve we should expect from model tests. The other diagram gives the ratio of the lift to the drag which is quite low compared with the values in ordinary conditions. This explains the low speed in a spin, because the weight is supported almost entirely by the drag while the lift balances the centrifugal force. Recently we have obtained an interesting confirmation of this curve. During the course of some work to determine accurately the stalling speed of an aeroplane we have obtained the drag curve up to an incidence of 40°, and this curve goes right through the middle of these points obtained from the spins.

This concludes my description of the spins, and I pass on to the theory of why an aeroplane spins. First of all I must leave the aeroplane and consider a single wing or aerofoil. Suppose the wing is mounted on an axis parallel to the wind direction through its centre of gravity, and is free to rotate about this axis. Will the wing remain at rest, or will it rotate? Fig. 4 shows the results of some experiments carried out at the National Physical Laboratory. Below 15° the aerofoil remains at rest, but at high angles it autorotates, slowly at first, and then more quickly. It is not difficult to see the reason of this rotation. If the right wing begins to fall, it gets a higher angle of incidence, and under ordinary conditions would get a higher lift, so that the air forces would stop the rotations. But if the mean incidence is above the stalling angle, the lift is less on right wing and the air forces accelerate the rotation. The aerofoil will then be unstable at rest.

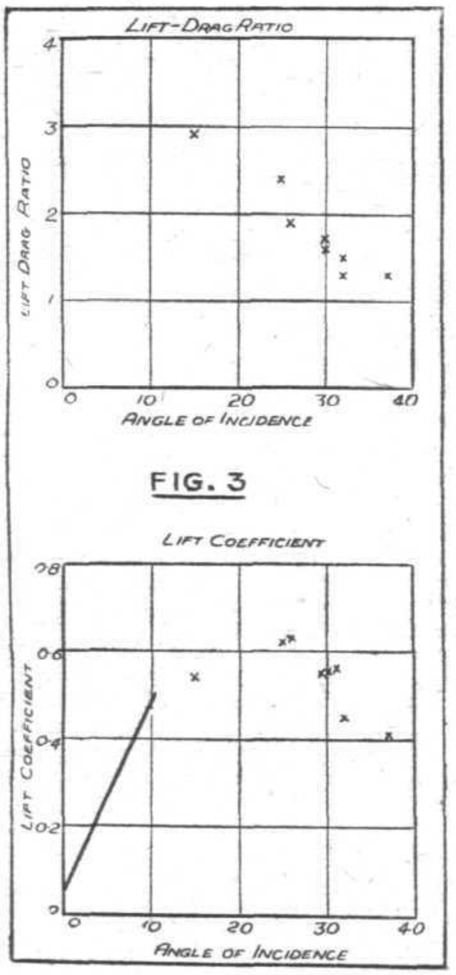


FIG. 3

Besides this change of incidence, the lift and drag forces are twisted through a small angle by the rotation, and the drag gives an upward component which tends to stop the rotation. The actual rate of rotation is given by balancing these two effects.

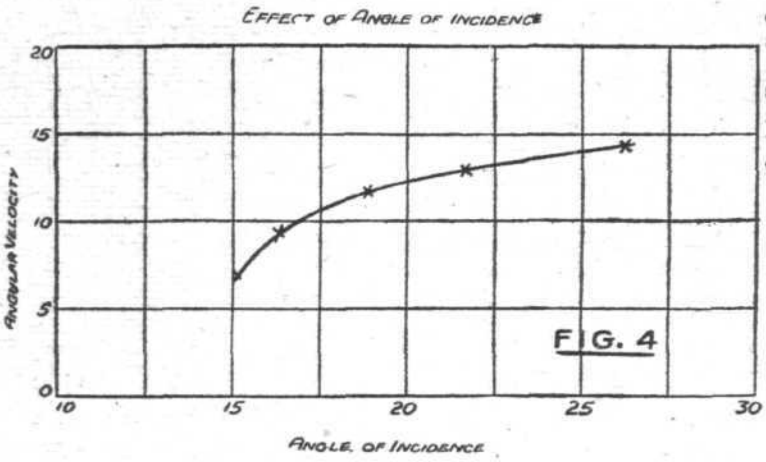
Fig. 5 shows the results of calculations made on these lines. The first part of the curve agrees with the observations shown in Fig. 4, but at higher angles the calculation has revealed certain peculiarities. Below 15° the aerofoil is stable at rest, from 15° to 27° it is unstable at rest and stable rotating, above 27° it is again stable at rest, but from 27° to 32° there are two possible rates of rotation, a slow unstable rotation and a fast stable rotation. This region has also been verified by later experiments.

It is not difficult to determine the limits of the range of autorotation, but the only one of real practical importance is the first limit where the wing becomes unstable at rest. This occurs when the slope of the lift curve is negative and numerically equal to the drag coefficient. For all practical purposes this limit can be taken to be the stalling angle. This explains why an aeroplane tries to spin as soon as it is stalled. It is unstable in straight flight, and any small disturbance starts a rotation.

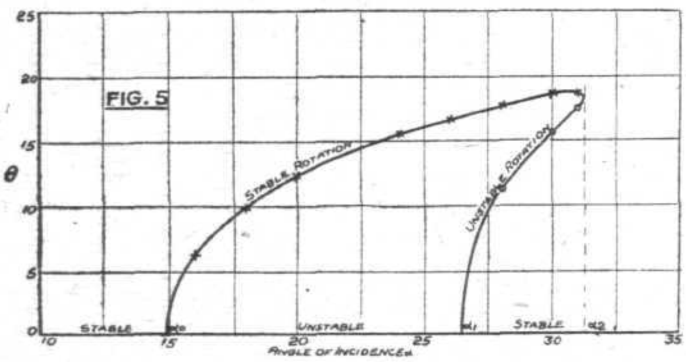
Fig. 6 shows these results in another form, a set of cubic curves. Each curve represents a definite angle of incidence, the abscissa is the rate of rotation, and the ordinate is the amount of the air forces stopping the rotation. If the curve

is above the axis the air forces will slow down the rotation, if it is above the axis they will accelerate it. The curves show that the aerofoil is unstable at rest from 16° to 26°. Also the rate of rotation is given by the point at which the curves cut the axis, and it is from these curves that Fig. 5 was constructed.

These autorotation results show that an aeroplane is unstable



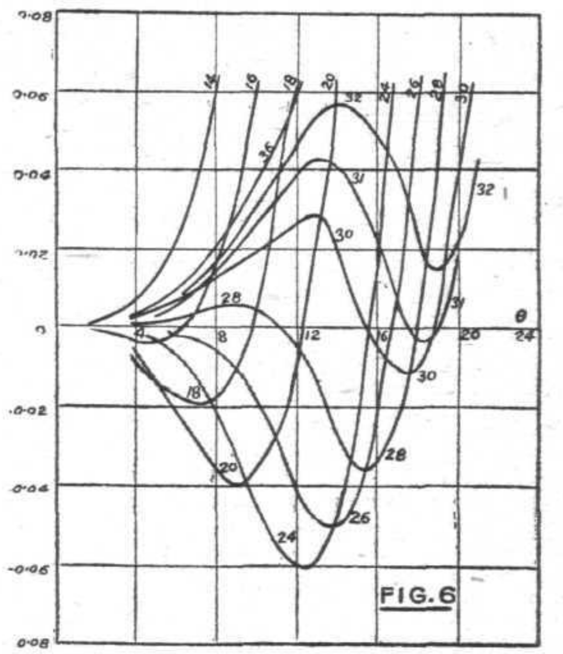
laterally when the incidence is above the stalling angle. The slightest disturbance causes one wing to drop, and a rotation to commence. Then the nose of the aeroplane also drops and a spin begins. The autorotation experiments cannot tell us the rate at which the aeroplane will spin; they merely give a relation between the rate of spin and the mean angle of incidence. This last quantity is determined by the position in which the various controls are held.



The complete analysis of the motion in a spin is too complicated to explain here, but it is easy to see that pulling the stick back gives a higher incidence and so a quicker spin. Other factors of importance are the rudder control and the wing loading, while less important effects are due to the span of the wings, the inertia of the aeroplane, and the *aileron* control.

In conclusion, I wish to mention two points. The manœuvre known as the roll is similar to the spin in many respects, but it is not a steady motion. Full rudder and elevator control are used, and there is little doubt in my mind that the quicker rotation in the second half of the roll is due to autorotation of the wings. The other point is a warning of how not to describe a spin, and it is a short article from a paper, reported to be technical:

"The cause of the nose spin appears to be unquestionably due to the machine going into a nose dive under full power and the propeller torque causing the wings to rotate horizontally about the propeller shaft. This theory is substantiated by the fact that the direction of the wings' rotation is always opposite to that of the propeller. Another fact that would bear out this theory is that a pilot can voluntarily execute the nose dive successfully, but when a machine



suddenly goes into a nose dive unexpectedly, it is reasonable to suppose that the spin has already begun before the pilot has had time to switch off his engine. Once this spinning motion of the wings has started, there is little that the pilot can do to save himself."

The article continues: "Assuming that the above theory is correct, it would seem that a solution of the problem would be to equip each machine with an automatic device for short-circuiting the engine when a certain forward angle of the machine is assumed, or to provide a reversing mechanism for the propeller shaft or the propeller pitch, with which the pilot could set up a reaction to the spinning motion when he found himself in that dangerous predicament."

There is little need to point out the fallacies of this article, but I am sure the remarks of any pilot who flew such an aeroplane would be very interesting.

PERSONALS

Death

Flying Officer CHARLES BOCKETT PUGH, D.F.C., aged 21, elder son of Mrs. Irene Bockett Pugh, and grandson of Mrs. Charles Paul, of Rodney Place, Clifton, was shot down and killed while engaged in the relief of Samawah, dropping supplies on to a defence ship on the Euphrates on September 22. Shortly after joining the Bristol University O.T.C. he received a commission in the R.N.A.S., going to France and thence to South Italy. In May, 1918, while taking part in a bombing raid over Cattero, his aeroplane was shot down and he was taken prisoner. After the Armistice he served in the Expedition to Dwina River, in North Russia, where he was awarded the D.F.C. In November, 1919, he was on service in Somaliland, and was awarded a Bar to the D.F.C. He volunteered for service in Mesopotamia, and proceeded there in July last.

Married

Flight-Lieut. JAMES LOGIE LYALL DUFFUS, R.A.F., eldest son of James Duffus, M.D., J.P., and Mrs. Duffus, or Auchenblae, Kincardineshire, was married on November 13, at All Saints' Church, Cairo, to HELEN VERA MARY, fourth daughter of Mrs. HANSON and the late ARTHUR STEPHEN HANSON, M.R.C.S., L.R.C.P., M.D., of Titchfield, Hants.

Flight-Lieut. ALAN GEORGE BISHOP, A.F.C., R.A.F., was married on November 6, at St. Saviour's, Brockenhurst, to VANDA PAMELA, daughter of Capt. DAYRELL DAVIES, R.N., and Mrs. DAYRELL DAVIES, "Walden," Brockenhurst, Hants.

Flight-Lieut. C. W. MACKEY, R.A.F., son of Mr. and Mrs. W. J. Mackey, of Maidstone, was married on November 10, at St. Luke's Church, Liverpool, to KATHLEEN, younger daughter of Professor and Mrs. BRIGGS, of Liverpool.

To be Married

The engagement is announced between Capt. G. DOUGLAS F. KEDDIE, late R.A.F., youngest son of Mr. G. J. Keddie, Hintlesham, Westcliff-on-Sea, and HILDA, only daughter of Mr. and Mrs. F. W. NAISH, of Crowstone Road, Westcliff-on-Sea.

The engagement is announced between STANLEY SEWARD HALSE (late Major, R.A.F.), second son of the late H. E. Halse, of Carnarvon Estate, Halseton, South Africa, and ETHEL LOVEDAY, younger daughter of Mr. and Mrs. G. B. PERCY SPOONER-LILLINGSTON, of 5, Leigham Terrace, Plymouth. The marriage will take place in December.

THE LONDON-CONTINENTAL SERVICES

FLIGHTS BETWEEN NOVEMBER 7 AND NOVEMBER 13, INCLUSIVE

Route	No. of flights*	No. of passengers	No. of flights carrying		No. of journeys completed†	Average flying time	Fastest time made by	Type and No. (in brackets) of Machines Flying
			Mails	Goods		h. m.		
Croydon-Paris	21‡	19	8	12	18	2 23	Airco 18 G-EAUF (1h. 10m.)	A.9 (6), A.16 (3), A.18 (1), B. (2), Bt. (1), G. (1), N. (2).
Paris-Croydon	17‡	22	3	9	14	2 34	Airco 16 G-EASW (2h. 20m.)	A.9 (3), A.16 (3), A.18 (1), B. (1), Bt. (1), Fa. (1), G. (2), N. (2).
Cricklewood-Paris ...	4	19	—	2	2	3 30	?	H.P. (4).
Paris-Cricklewood ...	4	15	—	2	3	3 34	H.P. G-EATG (3h. 15m.) ...	A.9 (1), H.P. (3).
Croydon-Amsterdam ...	—	—	—	—	—	—	—	—
Amsterdam-Croydon ...	—	—	—	—	—	—	—	—
Cricklewood-Amsterdam	—	—	—	—	—	—	—	—
Amsterdam-Cricklewood	—	—	—	—	—	—	—	—
Croydon-Brussels ...	3	3	3	2	2	2 16	Airco 4 O-BABI (2h. 15m.)	A.4 (3).
Brussels-Croydon ...	2	—	2	1	2	2 45	Airco 4 O-BABI (2h. 25m.)	A.4 (2).
Cricklewood-Brussels ...	3	—	2	2	2	2 10	Airco 9 G-EAUI (2h. 5m.) ...	A.4 (1), A.9 (2).
Brussels-Cricklewood ...	6	6	4	1	5	2 44	Airco 9 G-EAUN (2h. 12m.)	A.4 (1), A.9 (3), H.P. (1).
Totals for week ...	60	84	22	31	48			

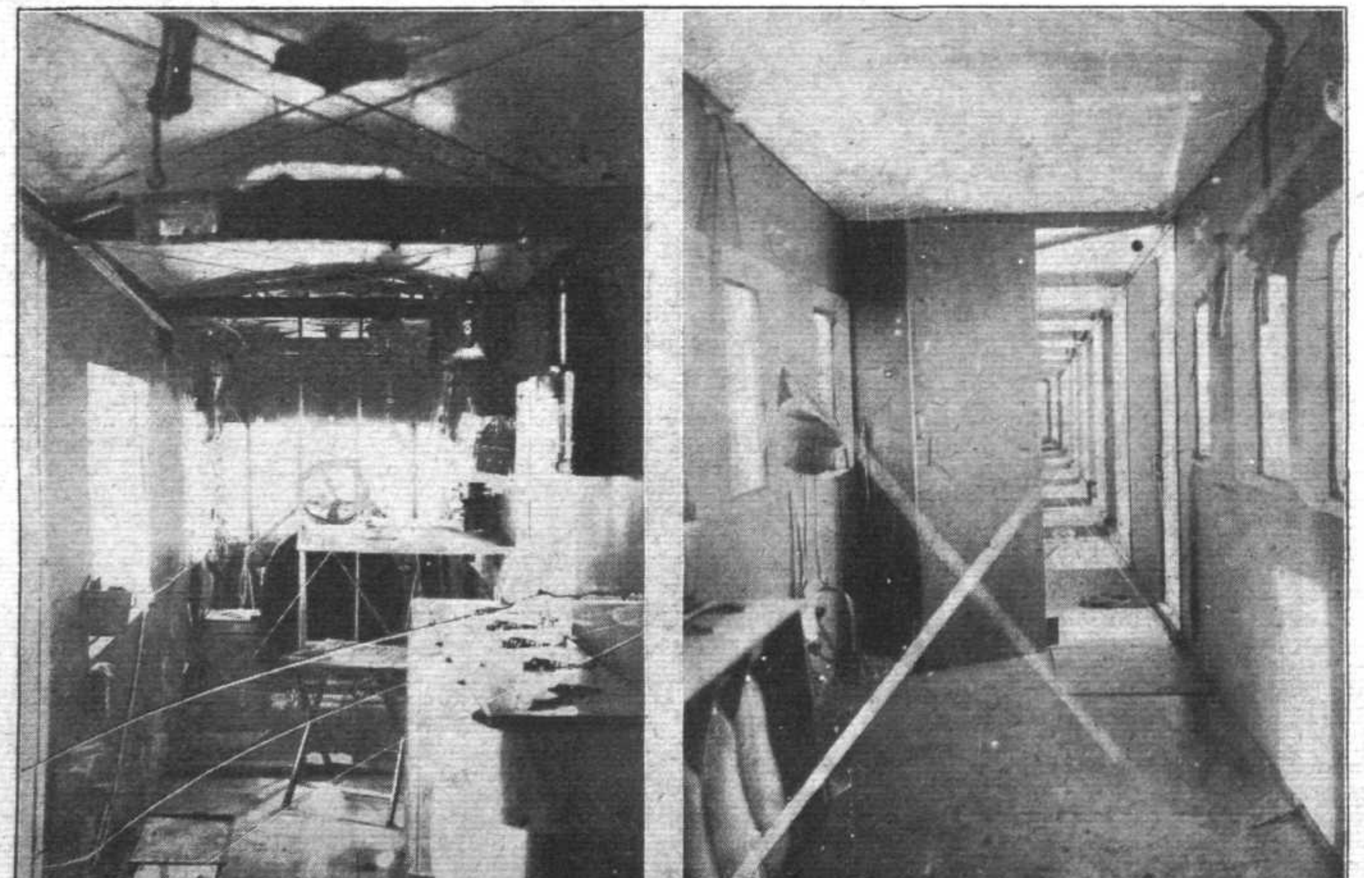
* Not including "private" flights. † Including certain journeys when stops were made *en route*.
‡ Including certain diverted journeys.

A.4 = Airco 4. A.9 = Airco 9 (etc.). Av. = Avro. B. = Breguet. Br. = Bristol. Bt. = B.A.T. F. = Fokker. Fa. = Farman F.50. G. = Goliath Farman. H.P. = Handley Page. N. = Nieuport. P. = Potez. Sa. = Salmson. Se. = S.E.5. Sp. = Spad. V. = Vickers Vimy. W. = Westland.

The following is a list of firms running services between London and Paris, Brussels, etc., etc. :—Air Post of Banks; Air Transport and Travel; Co. des Grandes Expresses Aériennes; Handley Page Transport, Ltd.; Instone Air Line; Koninklijkie Luchtvaart Maatschappij; Messageries Aériennes; Syndicat National pour l'Étude des Transports Aériens; Co. Transaérienne.

Limits of Size and Weight of Goods for Air Transport

GOODS of any description that come within the following weights and sizes can be forwarded at any time by air to the Continent through Handley Page Transport, Ltd :—Anything up to 4 ft. cube, not exceeding $3\frac{1}{2}$ cwt. in weight, or 12 ft. in length by 12 ins. in width and depth, not exceeding 2,000 lbs. in weight, or anything 6 ft. long by 2 ft. in width and 2 ft. in depth, not exceeding 2,000 lbs. in weight.



Interior views of the cabin of a Sikorsky biplane. On the left the fore part, and on the right looking towards the tail

AIRISMS FROM THE FOUR WINDS

SMART work that of the *Evening Standard* last week, when, by means of a special "Airco" 'plane, they were able to publish on the same afternoon photographs of the scenes attendant on the conveyal of the body of the "Unknown British Warrior" through Boulogne on its journey for embarkation on the British destroyer "Verdun." Evidently this new phase of journalism is spreading, and in this case with a really worthy subject for illustration.

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TRULY the net is now being spread wide enough for new jobs for air-pilots. The latest idea is through air research to "corner" foot-and-mouth disease outbreaks. The new theory that the virus of this horror is air-borne has been put up to the Ministry of Agriculture by Sir Stewart Stockman, its Chief Veterinary officer, who thinks that pilots may well be able to take a part in future research.

Sir Stewart shows that Great Britain is invaded by the disease only when the latter is prevalent on the Continent, and his researches have led him to discard the theories that people coming from the Continent, imported feeding-stuffs and litter, and migrant birds (excepting possibly those which come in spring from the south) may be the carrying agencies.

He thus puts forward the solution of the virus being air-borne for long distances. He declares: "Where affected cattle are allowed to remain alive in the open, as happens on the Continent, it is no uncommon thing to see strings of viscous slobber from the mouth whirled up into the air and dispersed into minute particles which disappear from sight."

He suggests that these particles "can be carried long distances by air-currents, even in clouds, and be washed down in rain." Exploration of the air, he thinks, would show whether in the areas mostly invaded there may not be something in the form of air-pockets of negative pressure which might account for suspended virus descending to earth or water.

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FROM Golden Albatross Ranch, British Columbia, an old colleague, of a roving nature, on the staff of FLIGHT sends us greeting. He came over when the Great Call came, and joined up with the R.N.A.S., in which before he had finished he did some pretty hefty sea-boat and 'plane work over the North Sea and elsewhere. His letter, from which the following are some extracts, is typical in showing how some of the "boys," after the Show is over, have solved the unemployment problem and settled down again in various corners of the Empire. His "P.P.S., "What do you think of the R.A.F. *now*?" is suggestive, and the rest of his communication is just what one might look for from "one of the boys" who helped the Empire in its need. "One is too busy," he says, "to write letters here in the summer time, and last winter I was still housebuilding, and there was too much of the pioneering about our life to make letter-writing a pleasure. This winter, however, I've located a steady and lucrative job, we are in a better position to withstand the cold, and with the long dark evenings, I expect to correspond quite a bit. That is, if I get any answers!

"We located here June, 1919, on a nice little ranch, which I bought with my gratuity, and have put in a very happy fifteen months on the whole. We are in a valley between the Rockies and the Selkirks at an altitude of nearly three thousand feet, and right on the banks of a beautiful lake, ten miles long and two miles broad. The population is entirely Old Country, and altogether things are very nice. Of course, we freeze up solid in the winter (45 below zero and two feet of ice on the lake kind of thing), and so cannot farm at this time of year, but in the summer it is hot, and you can grow any mortal thing—with irrigation.

"I very nearly popped back into flying this fall, but the non-arrival of the machine postponed operations till next spring, and I don't know whether I shall be piloting then or no. If so, it will be worth about $500 a month, about three times what I am now earning; but it is doubtful whether we should really be any better off in the long run, as it will cost nearly three times as much to live as it does here in the backwoods. You'd love this place. All kinds of hunting, from grouse and duck to mountain sheep and grizzly bears within thirty miles, and one's best friend is an axe. They say the 'old-timers' even strop their axes up of a Sunday to shave with. But you will note that I have a typewriter, and there are also a gramophone and a sewing-machine in the house, to remind us of civilisation.

"Please remember me to *all* the folks when you have a chance, and get them to send a line.

"Cheerio, and please make an effort and reply to this, if only a postcard, just to give me the satisfaction of knowing you have got it."

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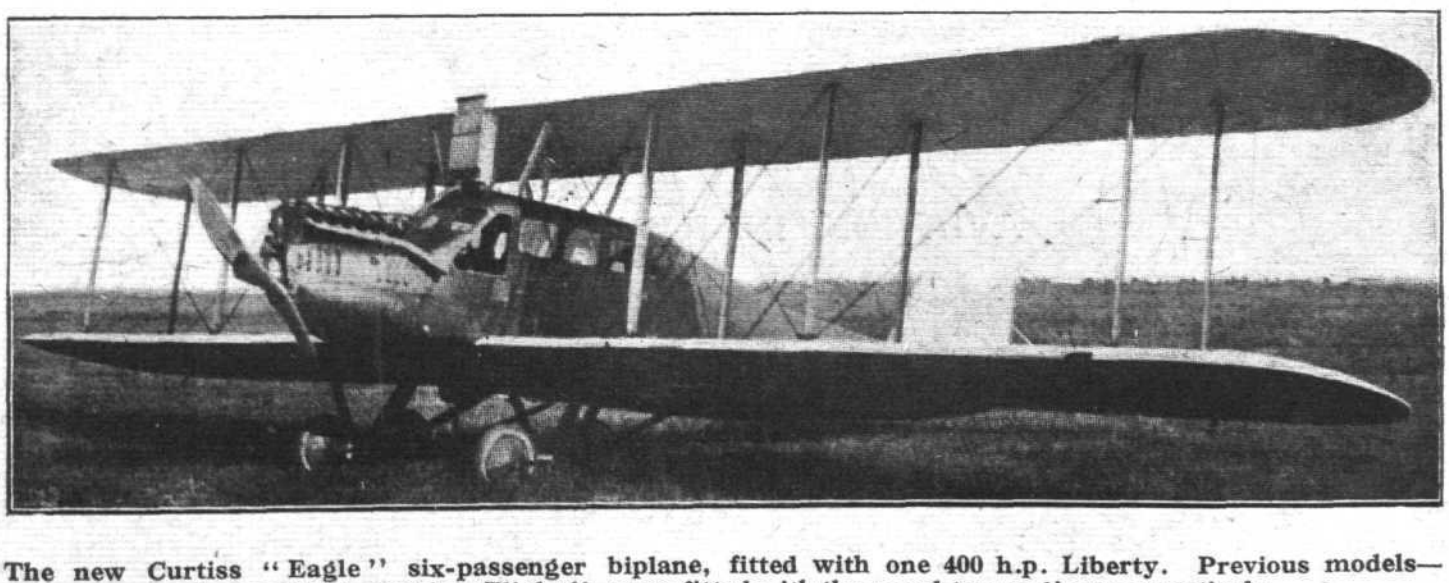
THERE appears to be quite a run upon "Stories of the Raids" just now. The latest contribution is from Maj.-Gen. Sir George Younghusband, Keeper of the Jewel House at the Tower, in his book, "The Jewel House," just issued by the house of Herbert Jenkins. In this Sir George describes how the Crown Jewels had a narrow escape when the Tower of London—their normal resting place—was bombed during an air-raid, and how they were then removed for safer custody to Windsor Castle for the duration of the War.

In their first daylight air-raids it appears, according to the author, the Germans made a special target of the Tower. The first bomb just missed the west side, buried itself in the dry moat, and failed to explode. A second went further east and hit the Royal Mint; the third damaged the railings on the north of the Tower, and killed a couple of van horses; and the fourth, the nearest shave of all, fell into the river within a few yards of St. Thomas's Tower.



The new Curtiss "Eagle" six-passenger biplane, fitted with one 400 h.p. Liberty. Previous models—already illustrated in "Flight"—were fitted with three and two engines respectively

IT should be noted that the total casualties to the credit of this attack on the Tower were one pigeon, which probably, says Sir George Younghusband, had a weak heart and died of shell-shock, and one pane of window broken in the Jewel House.

It was nevertheless decided that the Crown Jewels must be removed to some safer spot. When this became known there were the usual wild rumours about their destination.

One inspired person mentioned that, from certain information which he had received, a castle in Cornwall had been secretly acquired, and that the jewels had been taken there by special train at dead of night. He added that in front of the jewel train were two other trains, full of troops, police, detectives, machine guns, and what not.

Another very astute gentleman had secured the exclusive information that a deep and secret vault, lined throughout with concrete, had been excavated at Bath, and that the jewels were deposited there. The sole ground for this rumour rested on the undoubted fact that, eight months before, the Keeper of the Jewel House had been at Bath, and there, by way of camouflage doubtless, had undergone a course of the waters.

Other rumours included a statement that the jewels were in Cumberland, and that they had been sunk in the Thames opposite the Tower.

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As a matter of fact, they were at Windsor Castle, and their removal was a very tame affair.

A Royal car drove into the Tower of London and up to the Jewel House. Into it more important and valuable portions of the Regalia, already packed in their own cases, were handed. It was all a matter of a few minutes, and then the car drove away to Windsor Castle, and there deposited the jewels in a safe place.

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An aeroplane is undoubtedly an eliminator of space and handy to have around when a rapid "exit" is suddenly desired. On the other hand its conspicuousness during travel, aircraft may at times carry with it unexpected surprises which may more than counterbalance its advantages in all other dimensions. And so found Col. Semenoff, the leader of Cossack irregulars in Siberia, who at one time acted under Koltchak's orders, but later rebelled against his authority, has now fallen into the hands of the Bolsheviks.

Apparently he was fleeing from the Trans-Baikal territory as the result of a rising against his rule.

A Moscow wireless message says that in his flight from Chita he descended in an aeroplane near Makeevo Station where he was captured by irregular detachments.

How subsequent events proceeded for the moment, information is lacking.

MR. HENRY FOREMAN, M.P., has consistently identified himself with the Boy Scout movement, and the other day, at the Shepherd's Bush Empire, he again marked his appreciation of their work by presenting silver medals to selected West London Boy Scouts for their aid during the War in connection with the air-raids. The number of Scouts to whom Mr. Foreman has personally presented his medal is 26.

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TESTS FOR PILOTS OF REIKAVIEAKZZ

WE are able to give, this week, a résumé of the examination which all aspiring pilots of Reikavieakzz have to undergo before being admitted to the Royal Aeroplane Corps, Submarine Division :—

(1)—Name and locate at least six undiscovered islands in the Pacific Ocean.

(2)—Who invented the aeroplane ? When ? Why ? Give reasons.

(3)—How many revolutions a minute in rough figures ? Prove your answer.

(4)—How many gallons of gasoline are required to run an eight-cylinder motor which is quite powerful ?

(5)—Which is more efficient, an eight-cylinder motor with a four-foot propeller or a four-foot motor with an eight-cylinder propeller ? Is this the case with the conditions reversed ? Who ?

(6)—If on attaining a height of eight thousand three hundred and eighty feet seven and a half inches, it is found that the motor has been left on the ground, what is the correct procedure ?

(7)—Give the history of your life. (You may omit embarrassing details.)

(8)—In as many words as possible (one hundred at most), give the history of aviation.

If the pilots pass this test and still retain their sanity, they are put through another ordeal.

They are first hit upon the head with a one-hundred-pound hammer nine times to accustom them to falling from great heights and landing upon their craniums. If they still live after this test the examiners do not give up hope but go at the thing more seriously. While a cake of ice is held against the aspirant's stomach, molten lead is poured into his ears. This is calculated to accustom him to rapid changes in temperature. He is then put to work upon the stock-books of some mining company, which gives him a perfect idea of balance. Then follows the hardest test of all. He is led into a room in which are seated ten cullud gem'men and he is given a quick glance at their faces. If after three days he still can remember them, he is judged an expert in map-reading. Then if he has passed through all these ordeals, and the committee finds it absolutely impossible to find some test which he cannot pass, he is put in jail for defying the officers of the Government.—(*American Exchange.*)

CORRESPONDENCE

The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns.

"CONTINENTAL AIR LINES"

[2033] With reference to the advertisement appearing in the issue of FLIGHT of the 11th inst., I would point out that, contrary to the statements made therein, this busines is being proceeded with, and remains the property of the original proprietor—myself.

I would also bring to your notice that the advertisement was not authorised by me or anybody connected with the business.

Having proved by the experimental run of the machines from September 13 to the end of October that a regular daily service can be satisfactorily maintained, the business is being reorganised by me with a view to its development as a limited company, and its further operations.

I should be obliged if you would kindly give publicity to the above.

C. J. H. KENNEDY,
Proprietor, The Air Post of Banks, Ltd.

[2034] With reference to the advertisement in FLIGHT of this week, headed "Continental Air Lines" and making use of my name, I shall be glad if you will mention in your next issue that this advertisement was given to you not only without my approval, but very much against my wishes.

F. T. COURTNEY

AVIATION IN PARLIAMENT

Aircraft Destroyed

SIR W. DAVISON, in the House of Commons on November 8, asked the Prime Minister what is the estimated value of commercial and naval ships and airships which were to be handed over to the Allies under the Treaty of Versailles which have been wilfully and maliciously destroyed by the Germans; what was the estimated share of Great Britain in the property destroyed; and what additional reparation has been secured in lieu of the property thus wilfully destroyed ?

The Prime Minister (Mr. Lloyd George): There has been no destruction of naval ships since the Treaty of Versailles. With regard to airships destroyed, their value cannot be accurately estimated until the plans have been surrendered, but the airships will either be replaced or compensation exacted in some other form.

Feltwell Aerodrome

SIR R. WINFREY on November 9 asked the Secretary of State for Air whether it is proposed to utilise or abandon the aerodrome at Feltwell, in Norfolk; and whether the large area of agricultural land now uncultivated can be leased to the Norfolk County Council for the purpose of the settlement of ex-Service men ?

The Parliamentary Secretary to the Ministry of Munitions (Mr. James Hope): I have been asked to answer this question. With regard to the first part of the question, I would refer my hon. friend to the answer given on October 28 to my hon. friend the member for Twickenham (Sir W. Joynson-Hicks). With regard to the second part, the land formerly occupied as an aerodrome at Feltwell has been returned to the owner, with the exception of the site of the buildings.

R.A.F. Training

MR. GILBERT on November 10 asked the Secretary of State for Air if it is now the practice of the Air Force to train their own men for pilots, mechanics, etc., from youths entering the service; at what age youths are accepted for this training; if any educational or other test is required; for how many years the training lasts; how many training camps exist for this purpose and where they are situated; and what is approximately the number of such men at present under training ?

Sir A. Williamson: The answer to the first part of the hon. member's question is in the affirmative. The answers to the remaining parts cannot be conveniently given orally, as they involve replies to over 40 different points. If the hon. member is interested, he should communicate with the hon. member for Chatham (Lieut.-Col. Moore-Brabazon), who will be able to give him all the information he may require.

A STUDY OF AEROPLANE RANGES AND USEFUL LOADS

BY J. G. COFFIN

(*Continued from page 1181*)

PART II. Theoretical Analysis

Theory of Maximum Range Conditions

Notation:

- W = weight of machine at any time.
- W_f = weight of machine fully loaded with fuel.
- W_e = weight of machine empty of fuel.
- T = thrust of propeller.
- η = efficiency of propeller.
- A = supporting wing area.
- V = speed of flight.
- L = lift per unit wing area per unit speed at ground level.
- D = drift per unit wing area under same conditions.
- R = parasite resistance per unit wing area under same conditions and is assumed constant.

L and D depend only on the flying angle of attack.

- s = distance traversed in time t.
- S = range.
- $\gamma = \rho/\rho_o$ = ratio of the density of the air at height h to its density at ground level.
- c = lb. of fuel (gas and oil) per brake horse-power hour consumed by motors.
- $a = \frac{c}{\eta}$ = lb. of fuel per useful horse-power hour delivered by propeller.

The lift coefficient K_y, as usually given, is proportional to the density, and we may, therefore, write

$$K_y = k_y\rho = (k_y\rho_o)\rho/\rho_o = L\gamma$$

where L is the value of K_y at ground level.

The fundamental equations for horizontal flight of the aeroplane are

$$W = L\gamma AV^2 \qquad (1)$$
$$L = D\gamma AV^2 + R\gamma AV^2 = (D + R)\,\gamma\, AV^2 \qquad (2)$$

Condition for Minimum Work

The work done in flying a distance dl against a total drag T is Tdl. The total work done in flying a given distance s is, therefore,

$$\text{Work} = \int_o^s T dl$$

This work integral is evidently a minimum if T is always at its least possible value.

From equations (1) and (2) we get by division

$$T = W\left(\frac{D + R}{L}\right) \qquad (3)$$

This equation shows, since γ has disappeared, that for a constant angle of attack and given weight the thrust is independent of the height at which the flight takes place, and also that for a constant angle of attack the thrust is proportional to the total weight.

It is for the first reason that no mention of altitude was made in Part I. The second statement is verified in Fig. 2, which plainly shows very approximate proportionality at all actual flying speeds.

It is convenient to employ the polar diagram in the following: This kind of diagram deserves greater popularity than it has yet received in aeronautical calculations in the United States. It consists in plotting L as ordinates against D as abscissæ. Any point M on the curve corresponds to a given L and D, and hence to a given angle of attack. This angle of attack is marked on the curve.

Lay off from O the distance OQ equal to R.

Then for any point M, OB=D, MB=L, and OQ=R.

The slope of the line $QM = \frac{L}{D + R} = \tan \alpha$.

Consider equation (3). For a given weight and variable values of L and D, that is, for variable angles of attack, let us find the condition for minimum thrust.

$$dT = 0 = \frac{L\,(dD) - (D + R)\,dL}{L^2}$$

As L cannot be infinite, the condition is

$$\frac{dL}{dD} = \frac{L}{D + R} \qquad (4)$$

That is to say, for minimum thrust the tangent to the polar curve must have a value $\frac{L}{D + R}$. Looking at the polar diagram it is seen that the line QM_1 tangent at M_1 fulfils this condition and corresponds to a given angle of attack i_1. Since the polar is a given curve for the machine, it follows that

(*a*) for minimum thrust the machine must fly at a constant angle of incidence throughout the whole flight whatever the loading may be, and

(*b*) that these minimum thrusts are independent of altitude of flight.

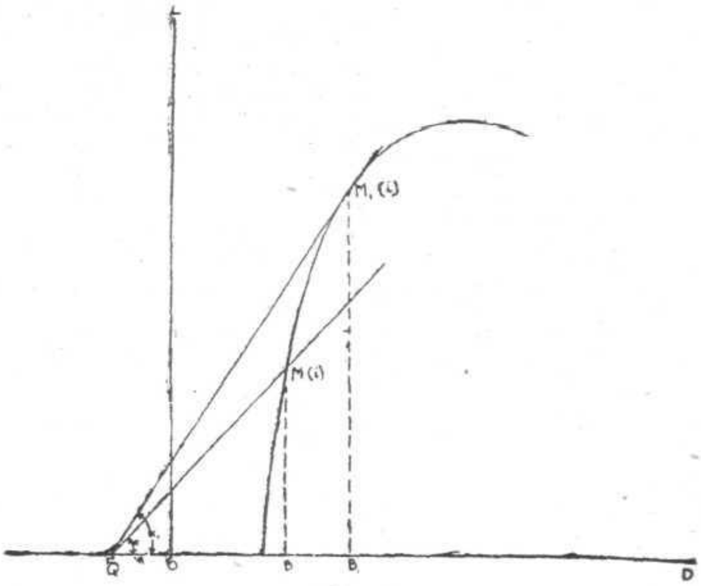


Fig. 7

In Part I, Table 2*b*, the angles of incidence corresponding to the least drag have been tabulated. They are remarkably constant, their average deviation from the mean 5·33° being only 0·12° and the greatest difference 0·3°.

For best range speeds, then, it follows that

$$W = C_1\gamma V^2 \text{ where } C_1 = LA \qquad (5)$$

and

$$T = C_2\gamma V^2 \text{ where } C_2 = (D + R)\,A \qquad (6)$$

where C_1 and C_2 are constants for flight at *any* constant angle of incidence. In particular for maximum range conditions they have the values corresponding to the maximum value of $\frac{L}{D + R}$ for the machine.

Let us suppose that the machine loses weight gradually due to fuel consumption alone. If the weight-distance curve can be deduced, the problem of bombing loads and ranges is solved, as explained in Part I.

Deduction of the Weight-Time Equation

Assume that the range of speeds is such that the engine runs at constant efficiency, burning "a" pounds of fuel per horsepower hour delivered by the propeller. If c = lbs. of fuel consumed per brake horsepower hour and the propeller efficiency is denoted by η, then the fuel consumed per horsepower hour delivered by the propeller is given by $a = \frac{c}{\eta}$.

The power at any speed is

$$TV = C_2\gamma V^2 \cdot V = C_2\gamma\left(\frac{W}{C_1\gamma}\right)^{3/2} = \frac{1}{\sqrt{\gamma}}\frac{C_2}{C_1^{3/2}}W^{3/2}. \qquad (7)$$

The rate of fuel consumption is aTV and in time dt a weight $aTVdt$ of fuel will be consumed, hence

$$aTV\,dt = \frac{1}{\sqrt{\gamma}}\frac{aC_2}{C_1^{3/2}}W^{3/2}\,dt = -\,dW. \qquad (8)$$

where $-\,dW$ is the loss of weight of the 'plane in time dt.

The weight of the 'plane at any time t is therefore, if W_f is the weight full,

$$W = W_f - \frac{a}{\sqrt{\gamma}}\frac{C_2}{C_1^{3/2}}\int_o^t W^{3/2}\,dt. \qquad (9)$$

Equation (8) is a differential equation for W at any time, and may be written

$$\frac{dW}{W^{3/2}} = -\frac{a}{\sqrt{\gamma}}\frac{C_2}{C_1^{3/2}}dt = -\,Kdt. \qquad (10)$$

where

$$K = \frac{a}{\sqrt{\gamma}}\frac{C_2}{C_1^{3/2}}. \qquad (11)$$

Solving and determining the constant of integration by the condition that when $t = 0$, $W = W_f$, we get

$$\frac{1}{\sqrt{W}} = \frac{K}{2}t + \frac{1}{\sqrt{W_f}}. \qquad (12)$$

This equation is the desired relation between W and t, and shows how the load diminishes as t increases. Since K contains γ, the rate of diminution of load depends upon the altitude.

The time of maximum flight can be obtained by letting W_f decrease to W_e, the weight of the empty machine.

$$t_{max} = \frac{2}{K}\left(\frac{1}{\sqrt{W_e}} - \frac{1}{\sqrt{W_f}}\right). \qquad (13)$$

This maximum time of flight computed with equation (13), using 1·03 lb. per horsepower hour as the average fuel consumption, gives a value of $t_{max} = 38 \cdot 3$ hours, as compared with $t_{max} = 38 \cdot 0$ hours as taken from the time-weight curve in Fig. 4. The two methods again check very well. The formula arranged to give the time in hours is, for low levels,

$$t \text{ (hours)} = 10550\left(\frac{1}{\sqrt{W_e}} - \frac{1}{\sqrt{W_f}}\right).$$

This time of flight diminishes proportionally to $\sqrt{\gamma}$.

Deduction of the Distance-Time Equation.

The distance traversed in time dt is, using (5),

$$ds = V dt = \sqrt{\frac{W}{C_1\gamma}}\, dt$$

so that in time t $\qquad s = \frac{1}{\sqrt{C_1\gamma}}\int_0^t \sqrt{W}\, dt$

which becomes, using (12),

$$s = \frac{2}{K}\frac{1}{\sqrt{C_1\gamma}}\int_0^t \frac{\frac{K}{2}\,dt}{\frac{K}{2}t + \frac{1}{\sqrt{W_f}}}$$

Integrating and determining the constant by the condition that when $t=0$, $s=0$, we get

$$s = \frac{2}{K}\,\frac{1}{\sqrt{C_1\gamma}}\log\frac{K/_2 t + \frac{1}{\sqrt{W_f}}}{\frac{1}{\sqrt{W_f}}} \qquad (14)$$

This equation is the desired relation between the distance flown and the time. The distance increases with the time, and depends upon the altitude of flight. For a given time interval the distance flown increases proportionally to $\frac{1}{\sqrt{\gamma}}$.

Determination of the Weight-Distance Equation.

Eliminate t between equations (12) and (14):

$$s = \frac{2}{K}\,\frac{1}{\sqrt{C_1\gamma}}\log\frac{\frac{1}{\sqrt{W}}}{\frac{1}{\sqrt{W_f}}} = \frac{1}{K\sqrt{C_1\gamma}}\log\frac{W_f}{W} \qquad (15)$$

where $\qquad \frac{1}{K\sqrt{C_1\gamma}} = \frac{\sqrt{\gamma}C_1^{3/2}}{aC_2\sqrt{C_1\gamma}} = \frac{C_1}{aC_2} = \frac{1}{a}\cdot\frac{L}{D+R}. \qquad (16)$

So that finally $\qquad s = \frac{1}{a}\cdot\frac{L}{D+R}\cdot\log\frac{W_f}{W}$

Or, more specifically in terms of c and η,

$$s = \frac{\eta}{c}\,\frac{L}{D+R}\cdot\log\frac{W_f}{W}. \qquad (17)$$

This equation is true for any condition of flight at constant angle of incidence, where the ratio $\frac{L}{D+R}$ remains constant.

For maximum range the maximum value of $\frac{L}{D+R}$ is of course used. This equation shows that as W diminishes s increases, and that the *distance* flown is independent of the flying altitude, since γ has disappeared.

The maximum range S can be obtained by finding the value of s for $W = W_e$.

Assume $W_f = 15{,}000$ lb.
$W_e = 7{,}130$ lb.
$$\text{Max.}\left(\frac{L}{D+R}\right) = 9 \cdot 2$$
$$S = 2{,}480 \text{ miles.}$$

We obtain for "a" a value of 1·03 lb. per horsepower hour. This value checks very well with $a = 1 \cdot 033$ lb. per horsepower hour, the average value used in the preceding greatest range calculations, in Part I. This check is very satisfactory, and shows that the two methods are in good agreement.

Equation Connecting Useful Load and Objective Distance.

If we let $b = \frac{1}{a}\,\frac{L}{D+R}$, equation 17 becomes

$$s = b\log\frac{W_f}{W},$$

and hence $\qquad W = W_f e^{-s/b}. \qquad (18)$

Considering Fig. 5 it is easy to see that the load B for any given objective at distance s is evidently, if S = max. range,

$$B = W_s - W_{S-s} = W_f(e^{-s/b} - e^{-(S-s)/b}) \qquad (19)$$

and since $W_e = W_f e^{-S/b}$ this becomes

$$B = W_f e^{-s/b} - W_e e^{s/b}. \qquad (20)$$

We can thus compute the useful load for any objective. If the weight—distance curve is plotted, however, it seems easier to plot the curve represented by (20) by the method explained above.

Proof that Load-Objective Curve is Straight.

In Part I the curve between useful load and distance to objective (Fig. 6) was very approximately a straight line. The equation for this curve is

$$B = W_f(e^{-s/b} - e^{-(S-s)/b}) \qquad (19)$$

where S is the maximum range, and s/b is a quantity which is smaller than unity and generally less than $\frac{1}{2}$.

This is not the equation of a straight line, but turns out to be very closely straight as seen by the following:

Let $x = \frac{s}{b}$, $x_1 = \frac{S}{b}$ for the moment.

Expanding the exponentials and neglecting *cubes* and higher powers of x, we have

$$e^{-x} - e^{-(x_1-x)} = 1 - x \times \frac{x^2}{2} - \left[1 - (x_1 - x) + \frac{(x_1 - x)^2}{2}\right]$$
$$= (2 - x_1)\left(-x + \frac{x_1}{2}\right) \qquad \text{a linear relation.}$$

The second powers have completely cancelled.

Therefore $\qquad B = \frac{W_f}{b}\left(2 - \frac{S}{b}\right)\left(-s + \frac{S}{2}\right) \qquad (21)$

When $\qquad s = \frac{S}{2} \qquad B = 0$

When $\qquad s = 0 \qquad B = \frac{W_f}{b}\left(2 - \frac{S}{b}\right)\frac{S}{2}$

But

$$W_f - W_e = W_f(1 - e^{-S/B}) = W_f\left(1 - 1 + \frac{S}{b} - \frac{S^2}{2b^2}\right) = \frac{W_f}{b}\left(2 - \frac{S}{b}\right)\frac{S}{2}$$

so that the straight line (20) passes through A and B as it should.

The curve then is a straight line to a high approximation, and can always be taken as such.

Effect of Climb at Start and Glide at End of Flight.

If the flight is so made that the 'plane is allowed to climb steadily as the load decreases, it must, of course, come down at the end of the flight when all the fuel is exhausted. The potential energy put into the 'plane by the consumption of a certain amount of fuel is then partially re-employed in the descent. A slight calculation shows that it is puerile to consider this effect, as shown below.

Assume that the 'plane rises under power to a height h with full fuel load, and at the end of the flight descends with power shut off and without fuel. The potential energy which cannot be regained is hence approximately the work done in raising the total weight of fuel to the maximum height reached. As shown previously, the expenditure of fuel is about 1 lb. per horsepower-hour delivered by the propeller, which is equivalent to

$550 \times 60 \times 60 = 1{,}980{,}000$ ft.-lb. of energy per lb. of fuel.

Assume 50 per cent. useful load (all fuel), the work required to raise the 'plane to a height h is

$$\frac{W}{2} \times h \text{ ft.-lb.},$$

which is a considerably overestimated value, as the climb is gradual, and the *total* fuel load is not raised to the maximum height.

Considering the specific machine used in Part I, the work done in raising 7,500 lb. of fuel to a height of 10,000 ft., say, is 75,000,000 ft.-lb. This amount of work would require

$$\frac{75{,}000{,}000}{1{,}980{,}000} = 38 \text{ lb.} = 6 \cdot 3 \text{ gallons of fuel}$$

(gas and oil), assuming 6 lb. to the gallon. As the total load is 1,250 gallons, this amount is about one-half of 1 per cent. of the total fuel load, which is quite negligible in calculations of this nature.

As the percentage amount for any other type of machine would be about the same, we have made no effort to take this theoretically interesting part of the subject into consideration.

Practical Simplified Method of Applying this Theory to a Specific Case.

The application of this theory to any specific case now reduces to the greatest simplicity as follows :—

Data required. W_f = weight fully loaded with fuel.
W_e = weight empty of fuel.
i_1 = angle of incidence for minimum total resistance.

1. Calculate the maximum range for an all fuel load by equation 17

$$S = \frac{\eta}{c}\left(\frac{L}{D+R}\right)_{max.} \log_e \frac{W_f}{W_e}$$

and plot the value of S/2 as abscissa for an ordinate B=0.

2. Plot $W_f - W_e$ as an ordinate for S=0.

3. Connect these two points by a straight line and we have a diagram similar to the following figure :

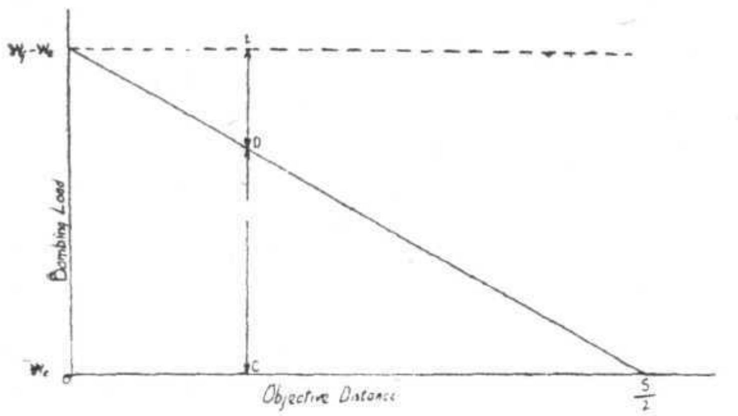


Fig. 8.

Any ordinate such as CD will give the maximum lb. of load that can be carried for an objective at distance OC. The distance DE will give the corresponding weight of petrol to be carried. (See Fig. 6.)

For usual machines

$$S \text{ (miles)} = 375 \frac{2.30}{1.03}\left(\frac{L}{D+R}\right)_{max.} \log_{10}\left(\frac{W_f}{W_e}\right) \quad (22)$$

Effect of Altitude on Speed, Power and Time.

From equation (5) it follows that for a given weight the speed must increase as γ diminishes, and the exact relation is

$$V_h = \frac{V_o}{\sqrt{\gamma}} \quad (23)$$

where h is the height characterised by γ. From equation (7) it follows that the power required for flight increases in the same proportion as the speed, so that

$$P_h = \frac{P_o}{\sqrt{\gamma}} \quad (24)$$

This is otherwise evident as the thrust does not change.

From the latest experimental tests of motor horsepower and motor efficiency at altitudes, it is found that the power falls off almost in proportion to the density, so that

$$P_h' = P_o'\gamma \quad (25)$$

Hence, to fly at an altitude characterised by γ, a power P_o' at the ground, which becomes $P_o'\gamma$ at the height, corresponding to γ, must be provided, such that

$$P_o'\gamma = \frac{P_o}{\sqrt{\gamma}} \quad (26)$$

If the maximum available horsepower P_o max. at the ground is provided, the 'plane will rise until

$$P_o \text{ max.}\ \gamma = \frac{P_o}{\sqrt{\gamma}} \quad (27)$$

or to such an altitude as is characterised by

$$\gamma = \left(\frac{P_o}{P_o\text{max.}}\right)^{2/3} \quad (28)$$

In order to provide a constant thrust the propeller must increase in angular speed according to the same law as the 'plane, since propeller blades are aerodynamically similar to wings, so that

$$n = (\text{RPM})_h = \frac{(\text{RPM})_o}{\sqrt{\gamma}} \quad (29)$$

It follows immediately from this that since V and n increase in the same ratio then $\frac{V}{nD}$ remains constant with altitude, and hence the propeller efficiency.

There are thus several reasons why flight at a high level will be better than at low.

(*a*) The motor running full open will probably use less fuel per horsepower than has been assumed for throttle, say, in the ratio of 0·6 to 0·7.

(*b*) The motor running at a higher speed can develop slightly more power with proper adjustment, which will increase the height, and therefore the speed.

(*c*) A very good third reason is that the duration of the flight will be considerably lessened, and this, together with

(*d*) the increased safety due to high altitude and greater flying speed, lead to the conclusion that : For bombing purposes the aviator should fly at a certain predetermined constant angle of attack ; he should allow the 'plane to rise as the load diminishes.

Since the work consumed in rising to the higher level is at least partially returned when the machine glides down at the end of the trip without power, these works have not been considered.

The aviator will thus attain the greatest range, carry the greatest load, secure the greatest safety and speed consistent with these conditions and economise in time as well.

Note on Ceilings

By employing the equation (28) :

$$\gamma = \left(\frac{P_o}{P_o\text{max.}}\right)^{2/3}$$

based upon the assumption $P_h = P_o\gamma$, the ceiling for any corresponding weight of machine may be found if the available and required horsepower is known.

The following table of computations refers to the machine considered in Part I.

Table of Ceiling Computations.

Weight in lb.	Available h.p. P_m.	Required h.p. P_o.	$= \frac{P_o}{P_m}^{2/3}$	Ceiling. (*a*)	Ceiling. (*b*)
15,000	600	320	0·658	12,500	10,350
13,000	582	265	·592	16,000	13,900
11,000	555	212	·527	19,600	17,900
9,000	518	159	·455	23,800	21,800
7,000	477	107	·368	29,600	25,600

The column (*a*) under the heading of ceiling in the above table has been obtained from a γ-altitude curve based upon data obtained from report No. 14 of the National Advisory Committee for Aeronautics.

The column (*b*) under "Ceiling" has been obtained from data on the average performance values of a number of machines.

(To be Concluded)

Bombing a Battleship

ALTHOUGH they succeeded in making a sorry mess of the obsolete U.S. battleship *Indiana*, which the American Government has passed over for aerial experimental purposes, the five seaplanes of the FSL type did not succeed in sinking her. While the battleship was under way at a speed of 10 knots—she was controlled over an erratic course by wireless from the *Ohio* five miles away—the seaplanes attacked her and five of the 25 bombs hit the target squarely. Part of the deck was torn up, the smoke stacks suffered severely, and the deck was strewn with débris, but the old battleship still remained afloat.

Quarantine for Aeroplanes

SINCE November 1 all aircraft entering the U.S. have been subject to the same restrictions as regards quarantine as apply to steamers. The first aircraft health inspector is stationed at Key West, Fla., where the machines arrive from Cuba. It will be necessary now for the officers in charge of these aircraft to obtain bills of health from the American Consul at Havana before starting on their flight.

Florida to Cuba by Air

AN aerial mail and passenger service between the United States and Cuba was recently inaugurated by the departure from Key West of two seaplanes for Havana.

Rain by Aeroplane

FOLLOWING the report of experiments in the Transvaal to produce rain by an aeroplane dropping dust on the clouds comes word from Winnipeg of another scheme with the same end in view. According to the *Daily Mail* correspondent at Winnipeg, Mr. A. E. Cole, father of Captain Homer Cole, formerly of the Royal Air Force, states that he and his son are planning to form an aerial irrigation company. Their scheme is to cause rain by spraying liquid air in the clouds from an aeroplane, causing the moisture in the atmosphere to condense. He claims that this will supply rain for agricultural districts subject to drought, and also serve to put out forest fires.

THE ROYAL AIR FORCE

London Gazette, November 2

Short Service Commissions

Flying Officer E. L. Zink resigns his short service commn.; Nov. 3.

Flying Branch

Lieut. G. H. L. Cox to be Lieut. (A.), from (O.); Feb. 1, 1919.

Pilot Officer G. L. P. Drummond to be flying Officer; Jan. 10 (since relinquished commn.).

Transfd. to Unemployed List.—Sec. Lieut. P. J. Windle; Feb. 1, 1919. Lieut. F. L. Hird, M.C.; Feb. 2, 1919. Sec. Lieut. W. H. Forster; March 6, 1919. Sec. Lieut. (Hon. Capt.) A. G. Inglis, Sec. Lieut. P. L. De La Plane; April 10, 1919. Sec. Lieut. R. A. P. Hales; April 13, 1919. Sec. Lieut. D. M. Megson; April 16, 1919. Lieut. P. A. Cooper; May 9, 1919. Sec. Lieut. G. Dobell; May 12, 1919. Sec. Lieut. W. L. Alderson; Sept. 12, 1919. Sec. Lieut. P. H. Davis; Sept. 26, 1919. Sec. Lieut. R. A. Talley; Oct. 13, 1919. Lieut. E. J. Cam; Oct. 22. Sec. Lieut. W. H. Paxman relinquishes his R.A.F. commn. and is permitted to retain his rank.

Notification in *Gazette*, March 12, concerning Lieut. E. A. Sewell is cancelled (*Gazette*, Sept. 17 to stand).

Administrative Branch

Sec. Lieut. T. W. B. Mill to be Lieut.; July 5, 1919 (since demobilised) (substituted for *Gazette*, May 25). Pilot Officer H. J. Gerred to be Flying Officer; Dec. 20, 1919 (since demobilised). Sec. Lieut. F. M. Hawthorn relinquishes his R.A.F. commn. on appt. to the T.F., and is permitted to retain his rank. Sec. Lieut. F. Dallow is transfd. to Unemployed List; Oct. 10, 1919.

Technical Branch

Pilot Officer A. de M. Mead to be Flying Officer without pay and allces. of that rank; Oct. 1, 1919 (since demobilised). Lieut. A. V. Pepperell is placed on the Retired List on account of ill-health caused by injuries sustained on active service; Nov. 3.

Transferred to Unemployed List.—Sec. Lieut. H. K. Swales; Feb. 3, 1919. Sec. Lieut. J. Milsted; March 1, 1919. Sec. Lieut. E. Knight; July 14, 1919. Maj. T. M. Barlow; Aug. 1, 1919. Capt. J. D. Campion; March 25 (substituted for *Gazette*, June 18).

Medical Branch

Capt. J. D. Cherry is transfd. to Employed List; Aug. 1 (substituted for *Gazette*, Aug. 20).

Memoranda

316438 Overseas Cadet F. A. Jordan is granted a temp. commn. as Sec. Lieut.; Feb. 15, 1919.

Ten Cadets are granted hon. commns. as Sec. Lieuts. with effect from date of their demobilisation.

P.F..O J. R. Young is granted hon. commn. as Sec. Lieut.; April 30, 1919.

Sec. Lieut. F. A. Jordan relinquishes his commn. and is permitted to retain his rank; April 30, 1919.

Hon. Sec. Lieut. R. H. Smith relinquishes his hon. R.A.F. commn.; Oct. 8, 1919.

London Gazette, November 5

Air Vice-Marshal J. F. A. Higgins, C.B., D.S.O., A.F.C., is restored to the Active List; Oct. 19.

Flying Branch

Lieut. (actg. Capt.) E. B. Humphries relinquishes his R.A.F. commn., on appt. to the T.F. and is permitted to retain the rank of Lieut.

Lieut. L. A. Colbert relinquishes his R.A.F. commn. on appt. to the T.F., and is permitted to retain his rank.

Transfd. to Unemployed List.—Sec. Lieut. D. J. Muil, Sec. Lieut. (Hon. Capt.) W. O. Ryan, M.C.; Jan. 26, 1919. Sec. Lieut. H. Douthwaite; Jan. 27, 1919. Sec. Lieut. R. D. Quin; Jan. 28, 1919. Sec. Lieut. J. A. Tyacke; April 4, 1919. Sec. Lieut. S. E. Pays; April 22, 1919. Lieut. S. L. Golding; April 29, 1919. Sec. Lieut. A. C. Stevenson; June 3, 1919. Sec. Lieut. (Hon. Lieut.) P. A. Lund; June 9, 1919. The surname of Lieut. H. W. Minish is as now described and not as stated in the *Gazette* of Sept. 24.

Administrative Branch

Sec. Lieut. A. Jukes, M.B.E., to be Lieut.; June 29, 1919.

Transfd. to Unemployed List.—Sec. Lieut. A. G. Darling; Feb. 8, 1919. Capt. A. Ridley, M.B.E.; Oct. 24.

Memoranda

The following Cadet is granted an hon. commn. as Sec. Lieut. with effect from the date of his demobilisation.—319288 G. A. R. Bocking.

London Gazette, November 9

Short Service Commissions

Sqdrn. Leader E. M. Bettington resigns his short service Commn.; Oct. 1.

Flying Branch

Sec. Lieuts. to be Lieuts.—J. R. Noble (since demobilised); June 6, 1919. J. R. Pairman; July 10, 1919.

Lieut. (Hon. Capt.) G. G. Roberts, M.C., relinquishes his R.A.F. commn. on appointment to T.F., and is permitted to retain rank of Capt. The following Lieuts. relinquish their commns. on appt. to T.F., and are permitted to retain their rank:—W. R. Adkins, L. C. Bower. Lieut. E. Belbin relinquishes his R.A.F. commn., and is permitted to retain his rank.

Transferred to Unemployed List.—Sec. Lieut. J. Hill; Feb. 2, 1919. Lieut. (Hon. Capt.) J. H. Hedley; Feb. 27, 1919. Lieut. J. Bremner; April 6, 1919. Sec. Lieut. W. J. Spicer; May 22, 1919. Sec. Lieut. H. A. Gilbert; July 13, 1919. Lieut. R. P. A. Crisp; August 11.

Lieut. G. L. P. Drummond relinquishes his commn. on account of ill-health caused by wounds, and is permitted to retain his rank; Sept. 28. (Substituted for *Gazette* Oct. 5.)

Sec. Lieut. O. D. Alward is antedated in his appointment as Sec. Lieut. (A. and S.); July 9, 1918.

Administrative Branch

Lieut. S. J. H. Coney is transfd. to unemployed list; Jan. 13. (Substituted for *Gazette* Jan. 16.)

The notification in *Gazette* Sept. 26, 1919, concerning Sec. Lieut. (actg. Lieut.) J. McCarthy is cancelled (*Gazette* June 3, 1919, to stand).

Technical Branch

Flying Officer (actg. Flight-Lieut.) W. Borland, M.B.E., relinquishes the actg. rank of Flight-Lieut. on ceasing to be employed as Flight-Lieut. Sept. 22. Sec. Lieut. H. C. Duckworth to be Lieut., Grade (B); Feb. 2, 1919 (since demobilised). Pilot Officer E. J. Rossiter to be Flying Officer, Grade (B); Oct. 1, 1919; Sec. Lieut. A. E. Curtis to be Lieut. without pay and allowances of that rank: April 19, 1919 (since demobilised). Sec. Lieut. (Hon. Lieut.) W. H. Gould relinquishes his R.A.F. commn. on appointment to the T.F., and is permitted to retain the rank of Lieut. Sec. Lieut. B. Moore relinquishes his R.A.F. commn., and is permitted to retain his rank.

Memoranda

Three Overseas Cadets are granted temp. commns. as Sec. Lieuts. with effect from Feb. 15, 1919, and relinquish such commns., with permission to retain the rank.

Seven Cadets are granted hon. commns. as Sec. Lieuts., with effect from the date of their demobilisation:—70560 R. Allen, 320605 H. G. Brixey, 37576 G. W. Wilkins, 28183 J. G. Bass, 155052 J. B. Kerr, 22075 J. B. P. Scott, 81186 G. W. Scott.

London Gazette, November 12

Permanent Commissions

Stores Branch

The following are granted permanent commns. in the ranks stated, with effect from dates indicated, retaining their present seniority, and are transfd. to the Stores Branch, with effect from June 17:—

Flight Lieut.—H. L. Crichton, M.B.E.; Sept. 16, 1919.

Flying Officers.—W. R. P. Allen, E. V. E. Andrewartha, H. P. Bridges, T. E. Drowley, E. I. T. Duffield, J. W. Gage, T. L. Grey, C. A. Longhurst, J. McCarthy, A. Walters, H. L. Woolveridge, F. C. Worton; Sept. 12, 1919. W. Best, A. T. Cooper, D. W. Dean, R. V. J. S. Hogan, L. T. Sanderson; Sept. 16, 1919. A. W. Smith; Jan. 20.

The notifications in the *Gazettes* of the above dates, appointing these officers to short service commns., are cancelled.

Short Service Commissions

Flying Officer T. V. Villiers relinquishes his short service commn. on account of ill-health contracted on active service, and is permitted to retain his rank; Nov. 13.

Stores Branch

The following are granted short service commns. in the ranks stated, with effect from the dates indicated, retaining their seniority in the substantive rank last held prior to the grant to this commn.:—

Flight Lieuts.—P. Adams, O.B.E., H. T. Foxen, E. D. Galloway, T. G. Gordon, M.B.E., G. Stevens; June 17.

Flying Officers.—R. Q. Bamber, R. Bassett, R. Blackith, C. H. Boreham, H. W. Clarke, F. E. C. Finzel, C. Harvey, H. B. Hawker, F. A. Ormerod, L. R. Peirce, J. A. Plunkett, J. Roberts, W. L. Shaw, O.B.E., F. S. Stokes, T. Surr, C. St. J. Vaughan; June 17. E. G. Steer; Oct. 11.

Air Vice-Marshal J. F. A. Higgins, C.B., D.S.O., A.F.C., is placed on the half-pay list, Scale (A); Oct. 28.

Flying Branch

Flight-Lieut. G. B. A. Baker, M.C., is restored to the active list; Nov. 8.

Sec. Lieut. G. H. Clarke relinquishes his R.A.F. commn. on ceasing to be employed; Feb. 20, 1919 (substituted for *Gazette* March 14, 1919).

Transferred to Unemployed List.—Capt. P. A. F. Belton; July 26, 1919. Sec. Lieut. T. Allan; Aug. 14, 1919. Sec. Lieut. (Hon. Lieut.) H. Goodier; Oct. 10, 1919. Lieut. R. A. Wade; Nov. 13, 1919 (substituted for *Gazette* Dec. 5, 1919.) Lieut. G. Rogerson; April 13.

Administrative Branch

Lieut. (Hon. Capt.) D. C. G. Sharp (Capt. R.H. and R.F.A.) relinquishes his temp. R.A.F. commn. on return to Army duty; Oct. 16.

Lieut. A. J. Litton, D.S.M., relinquishes his temp. R.A.F. commn. on ceasing to be employed, and is permitted to retain his rank; Nov. 3.

Lieut. H. F. Barnes, M.C., is transfd. to unemployed list; Aug. 4, 1919.

Technical Branch

Capt. F. Workman, M.C., to be actg. Maj. whilst employed as Maj., Grade (A), from Nov. 28, 1918, to April 30, 1919.

Capt. F. Workman, M.C., is graded for purposes of pay and allowances as Maj. whilst empld. as Maj., Grade (A); May 1, 1919.

Sec. Lieut. (Hon. Lieut.) G. F. Antell (Lieut. Canadian Ord. Corps) relinquishes his temp. R.A.F. commn. on ceasing to be empld; June 30, 1919 (substituted for *Gazette* Sept. 5, 1919).

Sec. Lieut. W. Renshaw is transfd. to unemployed list; Oct. 10, 1919.

The notifications in *Gazette* Aug. 5, 1919, concerning Capt. F. Workman, M.C., are cancelled.

Medical Branch

Capt. L. S. Goss (Surgeon Lieut. R.N.) relinquishes his R.A.F. commn. on return to the R.N.; May 6, 1919.

Memoranda

Two Cadets are granted hon. commns. as Sec. Lieuts. with effect from date of their demobilisation.

Those Truthful Germans

FROM a report received in Paris from Berlin, it appears that up to November 3 the Inter-Allied Aeronautic Commission had taken possession of 28,000 aero-motors—that is, 12,000 more than the Germans said they possessed.

The Commission is also said to have confiscated 18,000 machines, these being, it is understood, in addition to those which have been delivered in accordance with the terms of the Armistice.

Blood-Hounds by Air

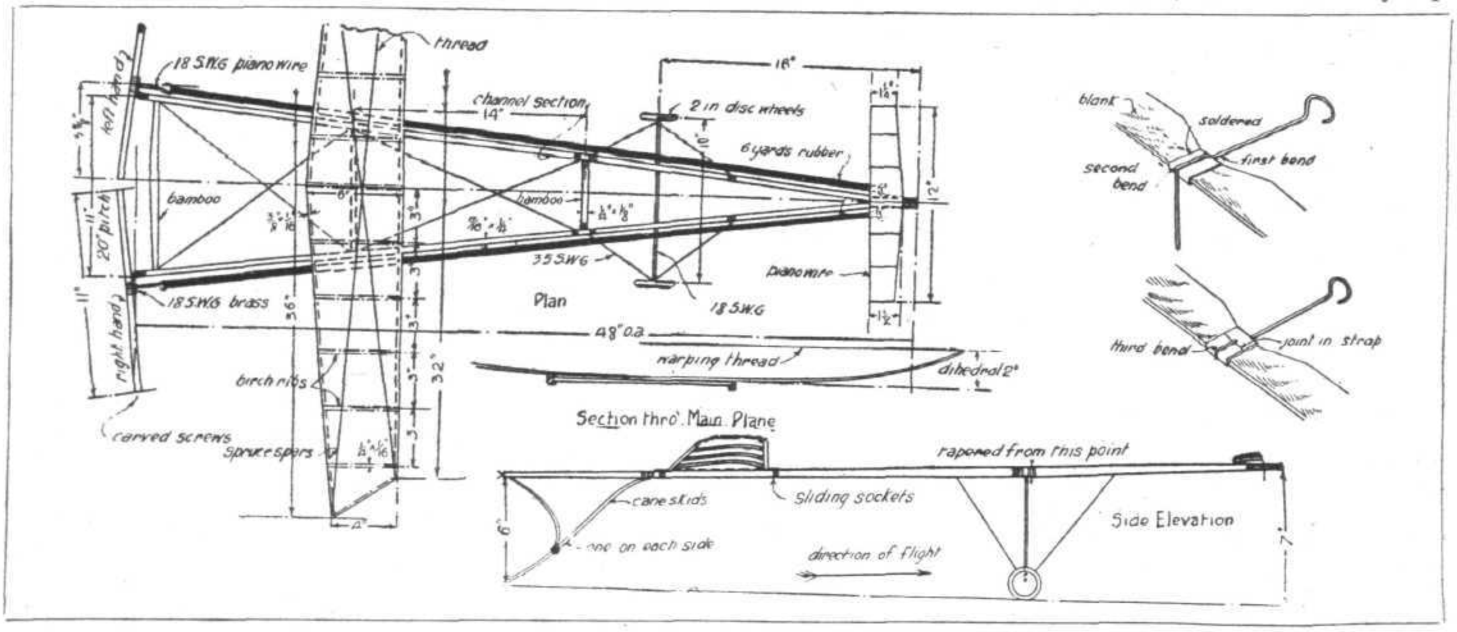
THERE have been several instances of aircraft rendering useful service to police authorities in various parts of the world, but the latest departure, reported from Chattanooga, Tenn., strikes a new note. It is stated that on receipt of a telegraphic message that a building of a coal-mining company at Pruden, in the same State, had been destroyed by incendiaries, blood-hounds were immediately sent over by aeroplane. So far, however, the result has not been announced.

MODEL AEROPLANES

NOTE.—*All communications should be addressed to the Model Editor. A stamp should be enclosed for a postal reply*

A 600-yard Monoplane

THE machine shown by the accompanying drawings, whilst being specifically designed for distance has, nevertheless, created a duration of 73 secs. The requests from readers for this type of model and matters relating to it tempt me to deal with such a machine in the series of models I intend, as previously intimated, to describe. The frame members are made of spruce, channelled in cross section, to the dimensions specified on the drawings. The bamboo cross members



are let into the channels at the distances noted by means of the usual fishplates and binding; their purpose is to give rigidity and the necessary propeller clearance. The rubber hooks are of the customary piano wire form. Bracing is passed from corner to corner of the bays formed by the cross members, to resist the torsion of the rubber when the latter is in tension.

The chassis is formed from piano wire of 18 S.W.G. braced in a fore and aft direction as shown in the side elevation. Sufficient propeller clearance should be given, and also a "starting angle" when on the ground. This can be adjusted by sliding the rear chassis in a fore and aft direction, as desired. The rear chassis consists of cone skids. Such an arrangement, where records are concerned, is quite sufficient to get the machine off the ground, and also to protect the screws. Use disc wheels (as obtained from our model advertisers) of 2-inch diameter. The main plane is cut from spruce, the ribs being of birch and cambered. The rear spar is bent to the swept-forward form given by the plan view.

The warping threads impart the dihedral angle (see side elevation).

The elevator is made from wire, with ribs bound and soldered into their correct position as given by the plan view. The downward-projecting central spoke adjusts the incidence by being a friction-tight fit within its seating. The screws should preferably be of bentwood for distance work, otherwise carved ones should be used.

Arrange the screws to revolve outwardly when viewing the machine from the rear, as I have found this to give not only better directional stabilty, but *greater thrust*.

The detail drawing given separately shows the correct method of forming the shafts. The band of tin is first pressed round and the joint soldered, and then finally squeezed into place as shown in the lower detail. I trust the drawing makes this matter clear, as many readers complain that they are unable to make a rigid job of this piece of construction.

The K.M.A.A.

AT a meeting held recently (when the writer owing to illness was unable to be present) of various persons well known in the model movement, it was unanimously decided to elect Mr. James McBirnie as Secretary, the present Secretary, Mr. A. H. Akehurst, being unfortunately unable to continue in office for business reasons. Mr. McBirnie is one of the early aeromodellists, and will, one is certain, fill the post quite satisfactorily. Messrs. A. E. Jones, also well known as *the* first firm in the model aeroplane accessory business, were represented in the aforementioned meeting by Mr. Moss. This firm, it is well to set on record, have consistently supported model aeroplaning from its inception as an organised hobby, and the number of prizes they have given (many of them anonymously) are tribute to the fact that their interest is not merely backed by business motives. Will all persons interested in the K.M.A.A. please communicate with Mr. W. H. Akehurst, 27, Victory Road, Wimbledon, without delay

Care of Rubber

THE most vulnerable part of the model aeroplane, the rubber motor, is often so carelessly looked after that the dealer supplying the rubber is blamed for selling inferior goods. The best quality, unless well lubricated with a pure lubricant, will snap before worn out. Again, rubber of too great a cross section is often used. There is no need to use $\frac{1}{4}$-in. strip rubber on models of $2\frac{1}{2}$ oz. or less; $\frac{1}{8}$-in. strip is quite good enough. Apart from exposing a greater area to the action of the lubricant, this enables the torque to be imparted at a more even rate, and also makes possible a longer length of flight by virtue of the greater number of turns available.

General Proportions

BRIEFLY, it can be stated that with *single screw* machines the propeller should not exceed $\frac{1}{3}$ of the span, the latter being about $\frac{5}{8}$ of the total length. The pitch of the propeller should be $1\frac{1}{2}$ times the diameter and the blade width $\frac{1}{8}$ in. to $\frac{1}{12}$ of the diameter. The wheel base should equal the diameter of the propeller. With twin screw machines the length of the machine can be twice the span, and the screws may be $\frac{5}{12}$ of the latter in diameter; the pitch should never exceed $3\frac{1}{7}$ times the diameter, when the pitch angle is 45°.

Replies to Correspondents

A.B. (Leicester).—I am replying direct to your letter as soon as I have looked into the matter.

J. van M. (The Hague).—I will give the desired drawing of the screws shortly.

H. B. (Leicester).—Many thanks for your interesting letter, which I hope to publish in the near future.

A. H. A. (Wimbledon).—I am sorry that a recent illness prevented me from attending the meeting.

J. A. C. (Blandford).—I replied direct.

The Air Express to Paris

COMMENCING this week, the 9.30 a.m. Airco express to Paris has been suspended for the winter months; the midday express leaves Croydon at 12.30 p.m., and is timed to arrive in Paris at 2.45 p.m. Extra aeroplanes will be put on as required in order that goods may be delivered the same day as they are dispatched. It is proposed to re-start the 9.30 a.m. and 4.30 p.m. services in the spring.

A Distinguished Visitor

DR. GRAHAM BELL, whose inventive genius gave us the telephone, and who was one of the pioneers of aviation in America, is now paying a "farewell visit" to this country, the land of his birth. Old readers of FLIGHT do not need to be reminded that Dr. Graham Bell was the head of the Aerial Experimental Association, the active spirits of which were Glenn H. Curtiss, J. A. Douglas McCurdy and Baldwin, who produced the "Silver Dart," "June Bug," and other machines, which flew at Baddeck, Nova Scotia. Dr. Graham Bell built what was called a tetrahedral machine, which consisted of a number of narrow planes with intermediate pieces arranged to form a large number of triangular "cells" as in a honeycomb.

An English Helicoptere

AMONG those in England who have been giving serious attention to direct-lift machines, is Mr. Louis Brennan of mono-rail fame, and it is understood that a machine he has built will shortly be put through some tests under official auspices.

A Wedding in the Air

FROM a brief note in the Indian papers to hand it appears that the "wedding in the air" notion has spread to India. From this we find that Mr. Charles Manson Mann, of Calcutta, was married on the afternoon of Oct. 17 to Miss Vera Kathleen Gardner in a Handley Page aeroplane flying over Calcutta. There was a full and complete wedding party on board, consisting of the couple and eight guests as well as the officiating clergyman and the best man. Capt. Stackard, a friend of the bride and bridegroom, was piloting, and the machine went up to 6,000 feet in 45 minutes. Then the engines were shut off, the aeroplane put into a slow glide, and the ceremony commenced. Without the noise of the engines there was silence on board, so that the words of the service were quite clear and audible. The ceremony went off without a hitch, and inside an hour from the time of the start the machine had landed and the bridal party had debarked. A cinema operator was amongst the guests, and he took a complete film of the ceremony.

A German-Swiss Service

ALTHOUGH the Basle-Frankfort service is indefinitely postponed, another attempt to link Germany and Switzerland by air is to be made; the Swiss "Ad Astra" concern proposing to start a regular postal service between Munich and Zurich. It is proposed that this shall be eventually connected with Geneva and then to Lyons and Paris.

To Our Readers

As we continually receive complaints from our readers that they experience difficulty in obtaining their copy of FLIGHT promptly each week, we would point out that under such circumstances the publishers will be glad to receive subscriptions. If the appropriate remittance is sent to the publishing offices, 36, Great Queen Street, W.C., it will ensure FLIGHT being received regularly each week upon the day of publication.

PUBLICATIONS RECEIVED

A History of 24 Squadron, Royal Air Force. By Capt. A. E. Illingworth and Maj. V. A. H. Robeson, M.C. London: The *Aeroplane* and General Publishing Co., Ltd., 61, Carey Street, W.C. 2.

Technical Note No. 15. Tests of the Daimler D-IVa Engine at a High Altitude Test Bench. By W. G. Noack. National Advisory Committee for Aeronautics, Navy Building, Washington, D.C., U.S.A.

La Chimie et la Guerre Science et Avenir. By Charles Moureau. Paris: Masson et Cie. Price 10 fr. net; by post, 10 fr. 50.

NEW COMPANIES REGISTERED

B. AND H. ENGINEERING CO., LTD., 43, Napier Road, Ponder's End, Middlesex.—Capital £3,000, in 1s. shares. Engineers, metal and wood workers, aeronautical engineers and general contractors, etc. First directors: G. E. Pacher and K. A. Hellon.

Correction: AIR NAVIGATION CO. (SCOTLAND), LTD.—The address *should read* 219, St. Vincent Street, Glasgow.

IMPORTS AND EXPORTS, 1919-1920

AEROPLANES, airships, balloons and parts thereof (not shown separately before 1910). For 1910 and 1911 figures see "FLIGHT" for January 25, 1912; for 1912 and 1913, see "FLIGHT" for January 17, 1914; for 1914, see "FLIGHT" for January 15, 1915; for 1915, see "FLIGHT" for January 13, 1916; for 1916, see "FLIGHT" for January 11, 1917; for 1917, see "FLIGHT" for January 24, 1918; for 1918, see "FLIGHT" for January 16, 1919; and for 1919, see "FLIGHT" for January 22, 1920.

	Imports.		Exports.		Re-Exportation.	
	1919.	1920.	1919.	1920.	1919.	1920.
	£	£	£	£	£	£
January ...	555,989	2,323	57,571	32,752	—	697
February	453,822	9,320	57,972	68,932	—	—
March ...	704,424	2,092	72,716	67,600	400	—
April ...	97,662	5,918	25,433	148,484	—	—
May ...	136,631	761,425	38,428	237,627	—	400
June ...	1,410	491	41,526	300,572	—	61,150
July ...	136,463	51,020	41,290	286,646	—	—
August ...	67,292	116	60,581	130,774	—	2,544
September	172,192	386	65,349	302,802	—	—
October ...	132,243	445	87,635	106,954	500	913
	2,458,128	833,536	548,501	1,683,143	900	65,704

AERONAUTICAL PATENT SPECIFICATIONS

Abbreviations: cyl. = cylinder; I.C. = internal combustion; m. = motors

The numbers in brackets are those under which the Specifications will be printed and abridged, etc.

APPLIED FOR IN 1917

Published November 18, 1920

10,936. R. M. BALSTON. Rotary engines. (152,695.)

APPLIED FOR IN 1919

Published November 18, 1920

17,095. E. R. CALTHROP'S AERIAL PATENTS and P. W. SCHOLLAR. Retaining and releasing devices for ropes, etc. (152,725.)

17,096. E. R. CALTHROP'S AERIAL PATENTS and P. W. SCHOLLAR. Spooling of tapes, etc. (152,726.)

18,240. J. J. M. A. E. SCHNEIDER. Aileron hinges. (141,314.)

19,963. F. J. CROWTHER. Inclinometers. (152,819.)

22,158. O. S. STILES. Kite balloons. (152,837.)

27,246. D. J. MOONEY. Fuselages, etc. (152,874.)

APPLIED FOR IN 1920

Published, November 18, 1920

10,176. M. KAPFERER. Wheels. (141,704.)

If you require anything pertaining to aviation, study "FLIGHT'S" Buyers' Guide and Trade Directory, which appears in our advertisement pages each week (see pages xvii and xviii).

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